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रेडियो व्यवधान लक्षणों की मापन पद्धतियाँ एवं सीमाएँ

भाग 1 वाहन, बोट तथा आन्तरिक दहन इंजन

(तीसरा पुनरीक्षण)

Indian Standard

LIMITS AND METHODS OF MEASUREMENTS OF RADIO DISTURBANCE CHARACTERISTICS

PART 1 VEHICLES, BOATS AND INTERNAL COMBUSTION ENGINES

(Third Revision)

ICS 27.020, 33.100.10

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NEW DELHI 110002

October 2010 **Price Group 14**

Electromagnetic Compatibility Sectional Committee, LITD 09

NATIONAL FOREWORD

This Indian Standard (Part 1) (Third Revision) which is identical with CISPR 12 : 2007 'Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of off-board receivers' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electromagnetic Compatibility Sectional Committee and approval of the Electronics and Information Technology Division Council.

This standard was first published in 1977 and subsequently revised in 1999. Now this standard has been revised to align with the latest IEC Publication. This standard describes limits and methods of measurement of radio disturbance characteristics from vehicles, motorboats and spark ignited engine driven devices. The limits for electromagnetic interference were earlier covered in IS 6842 : 1997 'Limits for electromagnetic interference — Specification (*second revision*)' which has since been withdrawn.

The text of IEC (CISPR) Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050-161 : 1990 International Electrotechnical Vocabulary (IEV) — Chapter 161: Electromagnetic compatibility	IS 1885 (Part 64/Sec 1 & 2) : 1987 Electrotechnical vocabulary: Part 64 Electromagnetic compatibility, Section 1 General terms, Section 2 Specific terms	Technically Equivalent
CISPR 25 : 1995 Radio disturbance characteristics for the protection of receivers used on board vehicles, boats, and on devices — Limits and methods of measurement	IS 15040 : 2001 Limits and methods of measurement of radio disturbance characteristics for the protection of receivers used on board vehicles	Identical

The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
CISPR 16-1-1 : 2006	Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-1: Radio disturbance and immunity measuring apparatus — Measuring apparatus

(*Continued on third cover*)

Indian Standard

LIMITS AND METHODS OF MEASUREMENTS OF RADIO DISTURBANCE CHARACTERISTICS

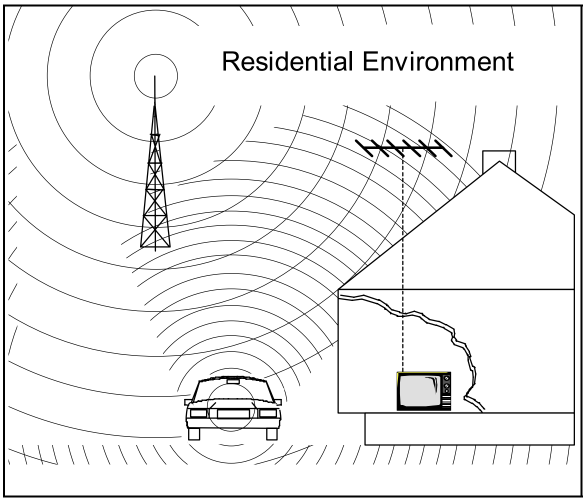
PART 1 VEHICLES, BOATS AND INTERNAL COMBUSTION ENGINES

(Third Revision)

1 Scope

The limits in this International Standard are designed to provide protection for broadcast receivers in the frequency range of 30 MHz to 1 000 MHz when used in the residential environment. Compliance with this standard may not provide adequate protection for new types of radio transmissions or receivers used in the residential environment nearer than 10 m to the vehicle, boat or device.

NOTE 1 Experience has shown that compliance with this standard may provide satisfactory protection for receivers of other types of transmissions when used in the residential environment, including radio transmissions in frequency ranges other than that specified.



This standard applies to the emission of electromagnetic energy which may cause interference to radio reception and which is emitted from

a) vehicles propelled by an internal combustion engine, electrical means or both (see 3.1);

b) boats propelled by an internal combustion engine, electrical means or both (see 3.2). Boats are to be tested in the same manner as vehicles except where they have unique characteristics as explicitly stated in this standard;

c) devices equipped with internal combustion engines or traction batteries (see 3.3).

See Annex G for a flow chart to help determine the applicability of CISPR 12.

This standard does not apply to aircrafts, household appliances, traction systems (railway, tramway and electric trolley bus), or to incomplete vehicles. In the case of a dual-mode trolley bus (e.g. propelled by power from either a.c./d.c. mains or an internal combustion engine), the internal combustion propulsion system shall be included, but the a.c./d.c. mains portion of the vehicle propulsion system shall be excluded from this standard.

NOTE 2 Protection of receivers used on board the same vehicle as the disturbance source(s) are covered by CISPR 25.

The measurement of electromagnetic disturbances while the vehicle is connected to power mains for charging is not covered in this standard. The user is referred to appropriate IEC and CISPR standards which define measurement techniques and limits for this condition.

Annex H lists work being considered for future revisions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

CISPR 16-1-1:2006, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-3:2004, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power*

CISPR 16-1-4:2007, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Radiated disturbances*

CISPR 16-2-3:2006, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 25, *Radio disturbance characteristics for the protection of receivers used on board vehicles, boats, and on devices – Limits and methods of measurement*

3 Terms and definitions

For the purpose of this document, the terms and definitions contained in IEC 60050-161 as well as the following apply.

3.1
vehicle
machine operating on land which is intended to carry persons or goods

NOTE Vehicles include, but are not limited to, cars, trucks, buses, mopeds, agricultural machinery, earth-moving machinery, material-handling equipment, mining equipment, floor treatment machines and snowmobiles.

3.2
boat
vessel intended to be used on the surface of water, its length being no greater than 15 m

3.3
device
machine driven by an internal combustion engine which is not primarily intended to carry persons or goods

NOTE Devices include, but are not limited to, chainsaws, irrigation pumps, snow blowers, air compressors, walk-behind floor treatment machines and landscaping equipment.

3.4
impulsive ignition noise
unwanted emission of electromagnetic energy, predominantly impulsive in content, arising from the ignition system within a vehicle, boat or device

3.5
ignition noise suppressor
that portion of a high-voltage ignition circuit intended to limit the emission of impulsive ignition noise

3.6
outdoor test site (OTS)
measurement site similar to an open area test site as specified in CISPR 16, however a ground plane is not required and there are dimensional changes

NOTE Specific requirements are defined in this document.

3.7
resistive distributor brush
resistive pick-up brush in an ignition distributor cap

3.8
frequency sub-band
segment of the frequency spectrum (30 MHz to 1 000 MHz) defined to enable statistical evaluation of the test data acquired by swept frequency testing

3.9
representative frequency
assigned frequency of a frequency sub-band to be used for comparison of the data to the limit

3.10
characteristic level
controlling (or dominant) emission level experienced in each frequency sub-band. The characteristic level is the maximum measurement obtained for both antenna polarizations and for all the specified measurement positions of the vehicle, boat or device. Known ambient signals are not considered part of the characteristic level.

3.11
tracking generator
test signal oscillator (continuous wave, cw) that is frequency locked to the receive frequency of a measuring instrument

3.12
RF disturbance power
RF power measured with a current transformer of an absorbing clamp and an RF measuring instrument. It may be measured – as the RF disturbance voltage – in a peak or quasi-peak mode

3.13
spark discharge
in this document, the discharge of energy stored in the ignition coil, in an arc across the electrodes of a measuring spark-plug

3.14
resistive high-voltage (HV) ignition cable
ignition cable whose conductor has a high resistance (attenuation)

3.15
residential environment
environment having a 10 m protection distance between the source and the point of radio reception and where the source uses the public low voltage power system or battery power

NOTE Examples of a residential environment include rooming houses, private dwellings, entertainment halls, theatres, schools, public streets, etc.

3.16
traction batteries
high power batteries used for electric vehicle traction applications

4 Limits of disturbance

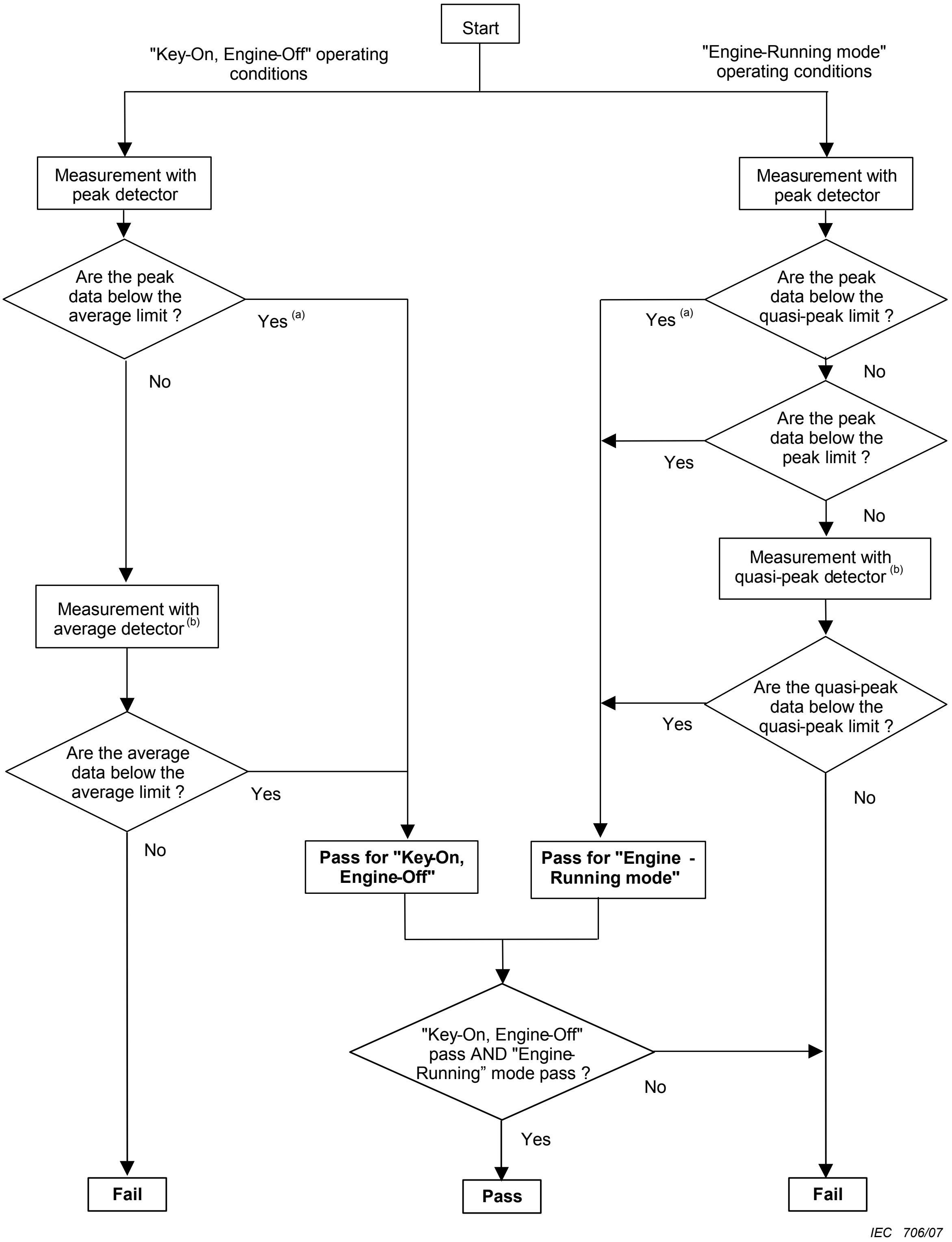
4.1 Determination of conformance of vehicle/boat/device with limits

In the 30 MHz – 1 GHz frequency range, the vehicle/boat/device shall comply with both:

- average limits when the vehicle/boat/device is in “Key-On, Engine-Off” mode (see 5.3.2.1), and
- peak or quasi-peak limits when the vehicle/boat/device is in “Engine-Running” mode (see 5.3.2.2)

The limits given in this standard take into account uncertainties.

Figure 1 defines the method for determination of conformance.


Start
"Key-On, Engine-Off" operating conditions
"Engine-Running mode" operating conditions
Measurement with peak detector
Are the peak data below the average limit ?
Yes (a)
No
Measurement with average detector (b)
Are the average data below the average limit ?
Yes
No
Fail
Measurement with peak detector
Are the peak data below the quasi-peak limit ?
Yes (a)
No
Are the peak data below the peak limit ?
Yes
No
Measurement with quasi-peak detector (b)
Are the quasi-peak data below the quasi-peak limit ?
Yes
No
Pass for "Key-On, Engine-Off"
Pass for "Engine - Running mode"
"Key-On, Engine-Off" pass AND "Engine-Running" mode pass ?
No
Yes
Pass
Fail
IEC 706/07

a Because measurement with peak detector is always higher than or equal to measurement with quasi-peak detector (and average detector respectively) and applicable peak limit is always higher than or equal to applicable quasi-peak limit (and average limit respectively), this single detector measurement can lead to a simplified and quicker conformance process.

b This flow-chart is applicable for each individual frequency, e.g only frequencies that are above the applicable limit need to be remeasured with quasi-peak detector (and average detector respectively).

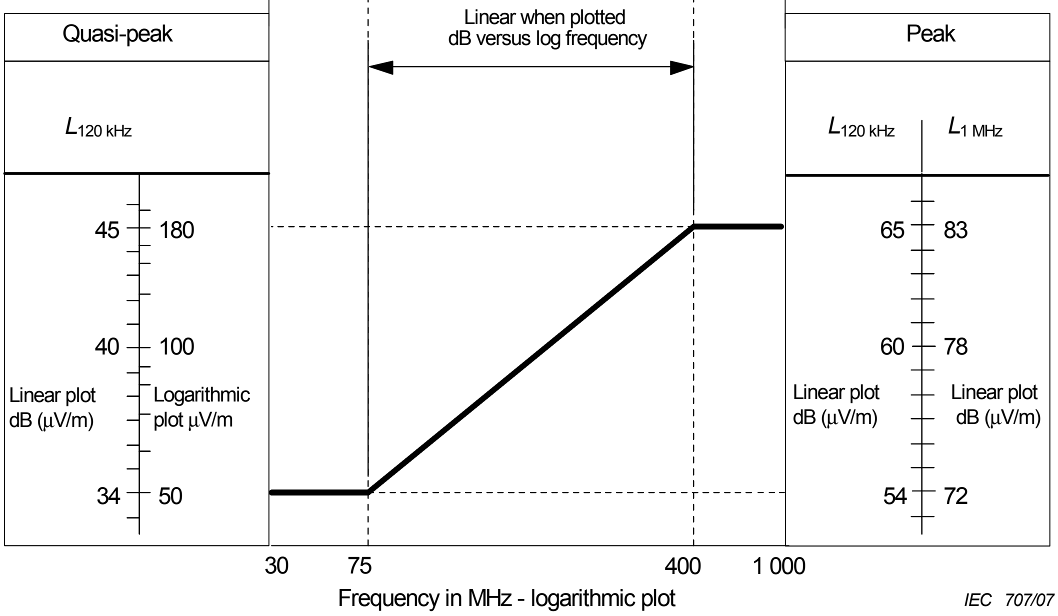
Figure 1 – Method of determination of conformance

4.2 Peak and quasi-peak detector limits

The limit for emissions measured with peak or quasi-peak detector at 10 m antenna distance is given in the table of Figure 2 and is shown graphically in Figure 2. Only one of the bandwidths listed needs to be chosen for testing. For more accurate determination, the equations given in Figure 2 shall be used. For measurements at 3 m antenna distance, 10 dB shall be added to the limit.

Limit L_{bw} in dB (µV/m) as a function of bandwidth, detector and frequency f in MHz

L_{bw}	30-75 MHz	75-400 MHz	400-1000 MHz	Measurement type
$L_{120\ kHz}$	34	34 + 15,13 lg (f/75)	45	Quasi-peak
$L_{120\ kHz}$	54	54 + 15,13 lg (f/75)	65	Peak
$L_{1\ MHz}$	72	72 + 15,13 lg (f/75)	83	Peak



IEC 707/07

NOTE 1 For vehicles equipped with electric propulsion motors, see 5.3.2.

NOTE 2 For peak measurements, see 5.5.

NOTE 3 The correlation factor between quasi-peak and peak measurements is +20 dB at 120 kHz bandwidth, based on experimental data accumulated in many countries.

Figure 2 – Limit of disturbance (peak and quasi-peak detector) at 10 m antenna distance

4.3 Average detector limit

The limit for emissions measured with the average detector at 10 m antenna distance is shown in Figure 3. Vehicles/boats/devices not including electronic oscillators with an operating frequency greater than 9 kHz shall be deemed to be in compliance with the average requirements of this clause without performing tests for emissions with average detector. Vehicles/boats/devices which meet the average emissions requirements of CISPR 25, Clause 5 shall also be deemed to be in compliance with the average requirements of this subclause and no further testing is necessary.

For measurements at 3 m antenna distance, 10 dB shall be added to the limit.

Annex D of CISPR 16-2-3 explains the differences between the CISPR AV detector and an AV detector (complying with CISPR 16-1:1999). For the purpose of this standard either detector may be used, since the pulse repetition rate for internal combustion engines is above 10 Hz.

NOTE For type-approval testing per 6.4, use of an alternative test method based upon other regulatory standards is permitted as detailed herein. This alternate type-approval test applies to those vehicles/boats/devices for which on-board receivers can be installed. If, when measured in accordance with the vehicle test methodology of CISPR 25 for emissions using an average detector, the signal strength at the vehicle/boat/device broadcast radio antenna is less than 20 dB (μV) (10 μV) over the frequency range 76 MHz to 108 MHz, then the vehicle/boat/device can be deemed to comply with the limits for average emissions and no further testing must be required.

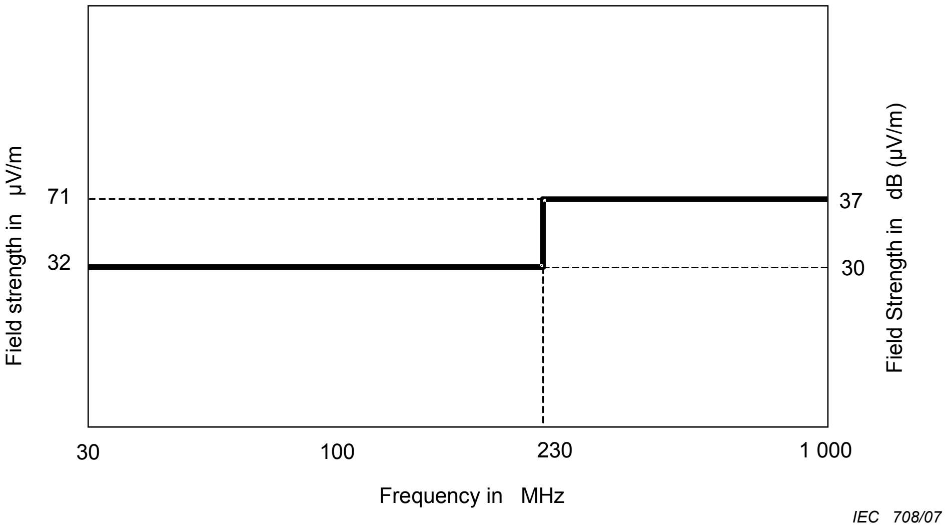


Figure 3 – Limits of disturbance (average detector) at 10 m antenna distance

5 Methods of measurement

5.1 Measuring instrument

The measuring instrument shall comply with the requirements of CISPR 16-1-1. Either manual or automatic frequency scanning may be used.

NOTE Spectrum analysers and scanning receivers are particularly useful for disturbance measurements. The peak detection mode of spectrum analysers and scanning receivers provides a display indication which is never less than the quasi-peak indication for the same bandwidth. It may be convenient to measure emissions using peak detection because of the faster scan possible than with quasi-peak detection.

When quasi-peak limits are being used, and a peak detector is used for time efficiency, any peak measurements with results at or above the test limit shall be re-measured using the quasi-peak detector.

5.1.1 Spectrum analyser parameters

The scan rate of the spectrum analyser shall be adjusted for the CISPR frequency band and detection mode used. The maximum scan rate shall comply with the requirements of CISPR 16-2-3.

The bandwidth of the spectrum analyser shall be chosen such that the noise floor is at least 6 dB lower than the limit curve.

NOTE A preamplifier may be used between the antenna and the spectrum analyser in order to achieve the 6 dB noise floor requirement.

The recommended scan time and bandwidth are listed in Table 1.

Table 1 – Spectrum analyser parameters

Frequency range MHz	**Peak detector**		**Quasi-peak detector**		**Average detector**	
	RBW[a)]	**Scan time**	**BW**[b)]	**Scan time**	**RBW**[a)]	**Scan time**
30 to 1 000	100 kHz / 120 kHz	100 ms / MHz	120 kHz	20 s / MHz	100 kHz / 120 kHz	100 ms /MHz

[a)] RBW is defined at –3 dB.

[b)] BW is defined at –6 dB.

If a spectrum analyser is used for peak measurements, the video bandwidth shall be at least three times the resolution bandwidth (RBW).

5.1.2 Scanning receiver parameters

The dwell time of the scanning receiver shall be adjusted for the CISPR frequency band and detection mode used. The minimum dwell time shall comply with the requirements of CISPR 16-2-3.

The bandwidth of the scanning receiver shall be chosen such that the noise floor is at least 6 dB lower than the limit curve.

NOTE A preamplifier may be used between the antenna and the scanning receiver in order to achieve the 6 dB noise floor requirement.

The recommended dwell time, maximum step size and bandwidth are listed in Table 2.

Table 2 – Scanning receiver parameters

Frequency range MHz	**Peak detector**			**Quasi-peak detector**			**Average detector**		
	Band-width	**Step size** [a]	**Dwell time**	**Band-width**	**Step size** [a]	**Dwell time**	**Band-width**	**Step size** [a]	**Dwell time**
30 to 1 000	120 kHz	50 kHz	5 ms	120 kHz	50 kHz	1 s	120 kHz	50 kHz	5 ms

[a] For purely broadband disturbances, the maximum frequency step size may be increased up to a value not greater than the bandwidth value.

5.1.3 Antenna types

5.1.3.1 Reference antenna

The antenna shall be a balanced dipole (see CISPR 16-1-4). Free-space antenna factors are to be used. For frequencies of 80 MHz or above, the antenna shall be resonant in length, and for frequencies below 80 MHz it shall be the length equal to the 80 MHz resonant length. It shall be matched to the feeder by a suitable symmetric-asymmetric transformer device.

5.1.3.2 Broadband antennas

Any linearly polarized receiving antenna is permitted, provided that it can be normalized to the reference antenna.

A broadband antenna shall be used when making measurements with an automated receiving system using a scanning measuring instrument. Such a broadband antenna is usable for measuring emission levels (over the frequency spectrum covered by this standard), provided that its output can be normalized to the output of the reference antenna in the actual test environment at the actual test site.

When broadband antennas are used, they shall meet the requirements for complex antennas given in CISPR 16-1-4. Examples of factors to be considered include:

a) the effective aperture area of the antenna, including its polar response (horizontal and vertical planes);
b) the effect of a phase centre which moves with frequency;
c) the effect of ground reflection characteristics (including multiple ray reflections which may arise at specific frequencies at about 500 MHz vertical polarization and 900 MHz horizontal polarization).

See Annex C for alternate antenna characterization.

5.1.4 Accuracy

The measurement system consisting of the antenna, transmission line and the measuring instrument, but excluding the source and the measuring site, shall measure electric field strength over the frequency range of 30 MHz to 1 000 MHz with an accuracy of ±3 dB. See Clause 4 of CISPR 16-1-4. The frequency accuracy shall be better than ±1 %.

NOTE 1 To ensure that the measurements defined in this standard are within the stated tolerances, consideration should be given to all pertinent characteristics of measuring equipment (for example, frequency and amplitude stability, image rejection, cross-modulation, overload levels, selectivity, time constants, and signal/noise ratio), as well as those affecting the antenna and transmission line.

NOTE 2 It is reasonable to expect additional variations in measurements made of an electric field (see C.13) within the range of 30 MHz to 1 000 MHz. These are caused by variations in ground conductivity and other factors influencing repeatability.

5.2 Measuring location requirements

5.2.1 Outdoor test site (OTS) requirements

5.2.1.1 OTS for vehicles and devices

The test site shall be a clear area, free from electromagnetic reflecting surfaces within a circle of minimum radius 30 m measured from a point midway between the vehicle or device and the antenna. As an exception, the measuring equipment, and test hut or vehicle in which the measuring equipment is located (when used) may be within the test site, but only in the permitted region indicated by the crosshatched area of Figure 4.

NOTE The site requirements defined in 5.2.1.1 and Figure 4 are the application of CISPR 16-1-4 to large automotive objects.

Vehicles and devices smaller than 2 m in length and width may be tested on an OTS with dimensions corresponding to CISPR 16-1-4, Figures 2 or 3.

5.2.1.2 OTS for boats

The test site shall be a clear area free from electromagnetic reflecting surfaces within a circle of minimum radius 30 m measured from a point midway between the engine under test and the antenna. Exceptions for the measuring equipment are specified in 5.2.1.2.1 and also in 5.2.1.2.2. As an exception, the measuring equipment may be within the test site, but only in the permitted region indicated by the crosshatched area of Figure 5. The test hut or vehicle or non-metallic boat of test fixture in/on which the measuring equipment is located may be within the test site.

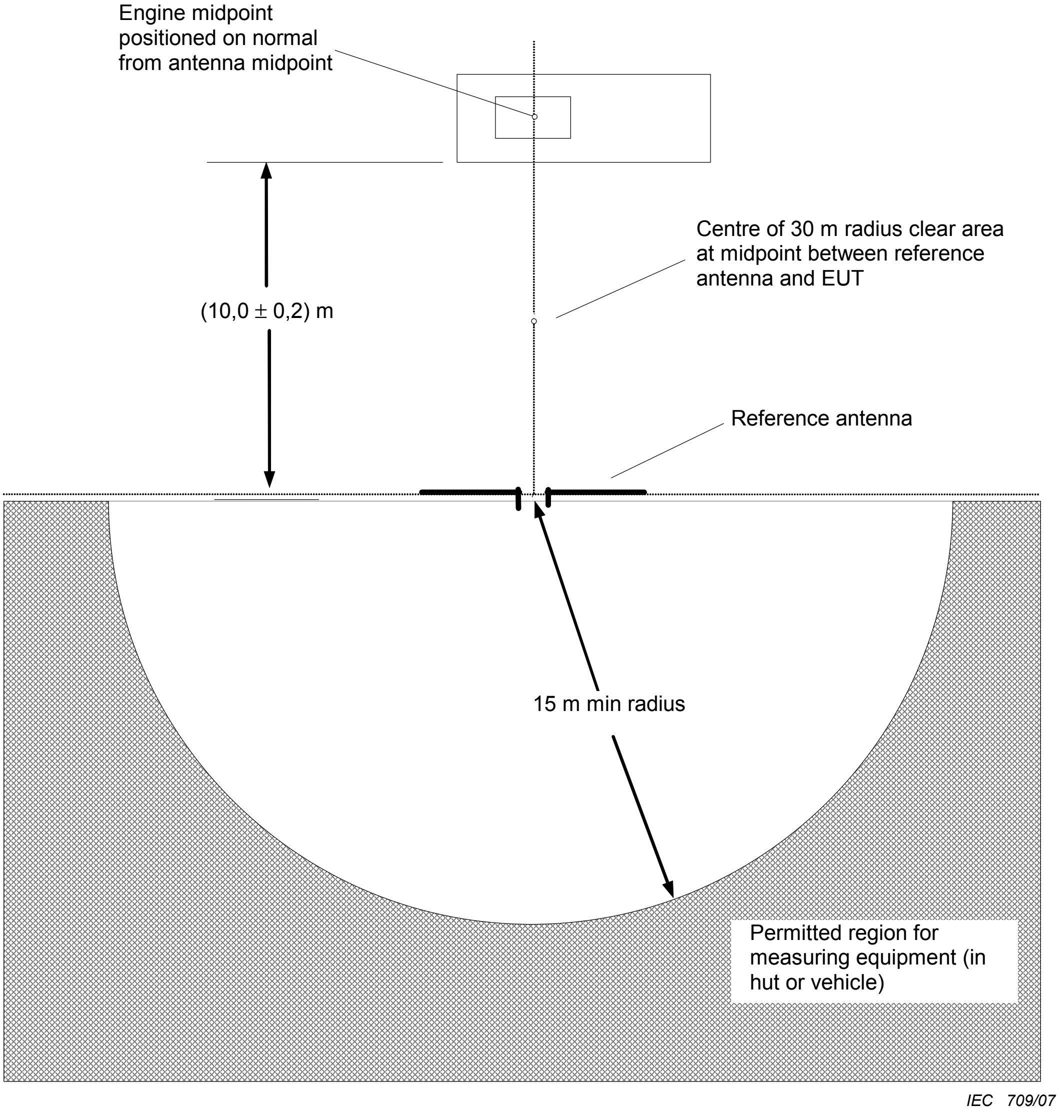
Boats or engines/motors for boats tested separately shall be tested in salt or fresh water at a measuring site as shown in Figure 5.

5.2.1.2.1 Land-based measuring equipment

When the measuring equipment is on land, the test hut or vehicle in which the measuring equipment is located may be within the test site, but only in the permitted region indicated by the cross-hatched area of Figure 5.

5.2.1.2.2 Water-based measuring equipment

The measuring equipment shall be installed in a non-metallic boat or non-metallic test fixture which may be within the test site, but only within the permitted region indicated by the cross-hatched area of Figure 5.


Engine midpoint positioned on normal from antenna midpoint
Centre of 30 m radius clear area at midpoint between reference antenna and EUT
(10,0 ± 0,2) m
Reference antenna
15 m min radius
Permitted region for measuring equipment (in hut or vehicle)
IEC 709/07

NOTE The 10,0 m ± 0,2 m dimension may be changed to 3,00 m ± 0,05 m in accordance with 5.2.3.2 and 5.2.3.4.

Figure 4 – Measuring site (OTS) for vehicles and devices

5.2.1.3 Ambient requirements

To ensure that there is no extraneous noise or signals of sufficient magnitude or density to affect materially the vehicle measurement, ambient measurements shall be taken before and after the main test, but without the vehicle/boat/device under test running. In both of these measurements, the ambient noise shall be at least 6 dB below the limits of disturbance given in Clause 4, excluding intentional radiators. When assessing compliance in accordance with Clause 6 any emission exceeding the limits shall require investigation to ensure that they are not attributable to the vehicle/boat/device in order to be excluded.

NOTE For further guidance, see 5.4 of CISPR 16-1-4.

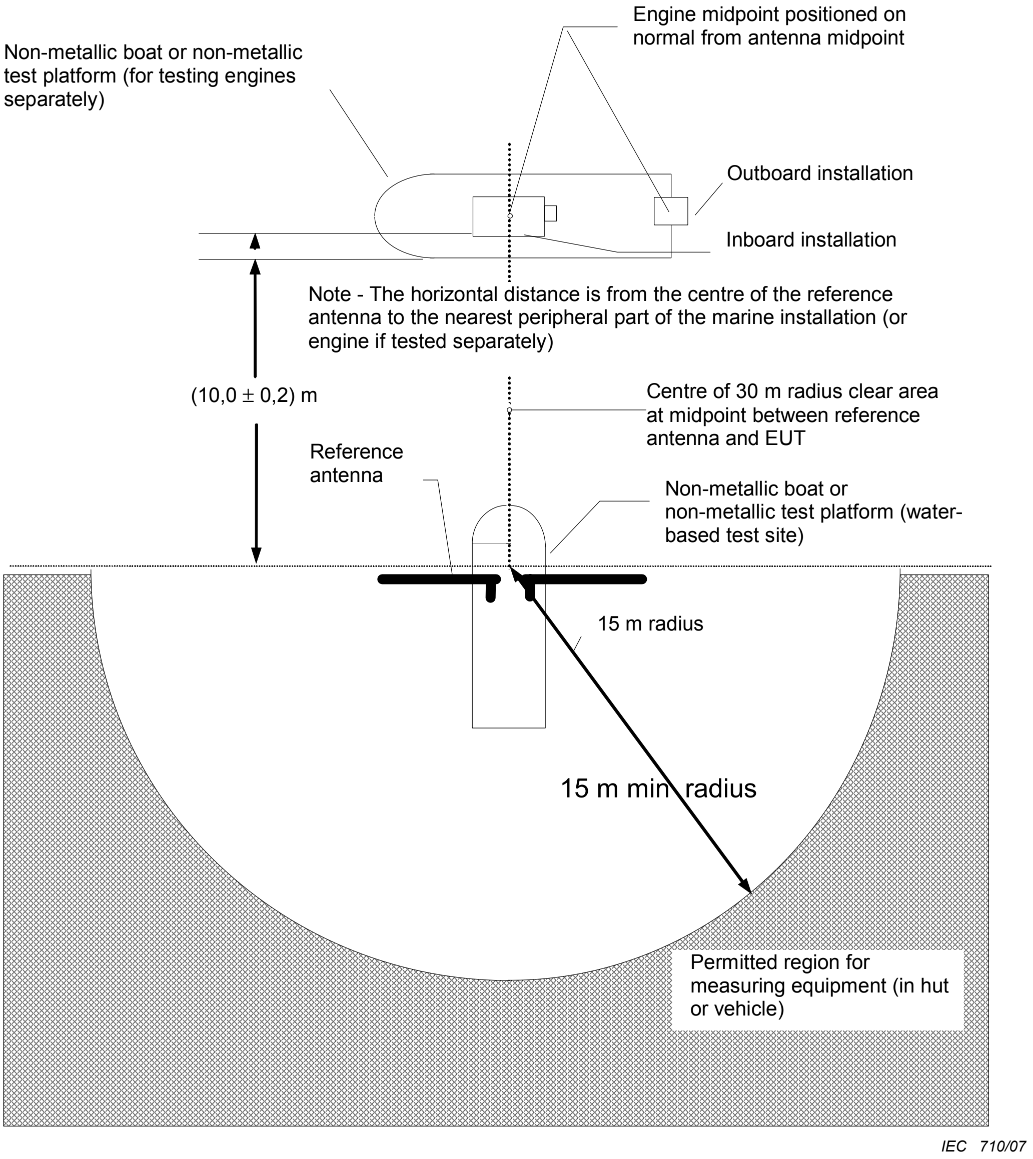

Engine midpoint positioned on normal from antenna midpoint
Non-metallic boat or non-metallic test platform (for testing engines separately)
Outboard installation
Inboard installation
Note - The horizontal distance is from the centre of the reference antenna to the nearest peripheral part of the marine installation (or engine if tested separately)
(10,0 ± 0,2) m
Centre of 30 m radius clear area at midpoint between reference antenna and EUT
Reference antenna
Non-metallic boat or non-metallic test platform (water-based test site)
15 m radius
15 m min. radius
Permitted region for measuring equipment (in hut or vehicle)
IEC 710/07

Figure 5 – Measuring site (OTS) for boats

5.2.2 Absorber lined shielded enclosure (ALSE) requirements

5.2.2.1 Correlation

Absorber lined shielded enclosures may be used provided that the results obtained can be correlated with those obtained using the OTS described in 5.2.1.

NOTE Such chambers have the advantages of all weather testing, controlled environment and improved repeatability because of stable chamber electrical characteristics.

5.2.2.2 Ambient requirements

The ambient noise level shall be at least 6 dB below the limits of disturbance given in Clause 4. The ambient level shall be verified periodically or when test results indicate the possibility of non-compliance.

5.2.3 Antenna requirements

At each measurement frequency (including the end frequencies), measurements shall be taken for horizontal and vertical polarization (see Figures 6 and 7).

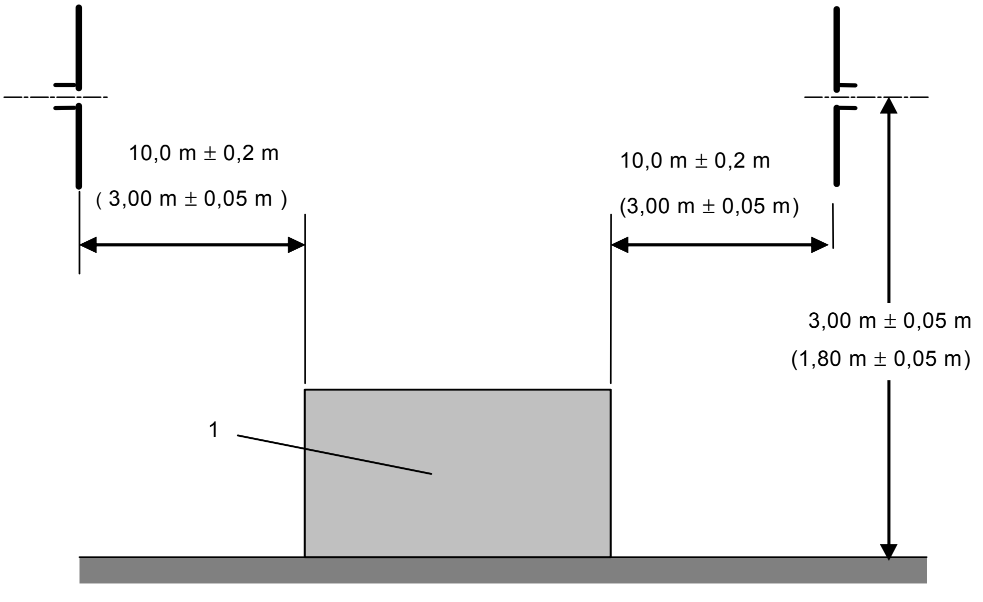
Electrical interaction between the antenna elements and the antenna support/guy system shall be avoided.

Theoretical considerations of antenna and transmission line geometry demand that the transmission line does not interact electrically with the antenna elements.

NOTE One acceptable transmission line geometry for a dipole antenna routes the transmission line horizontally rearward for a distance of 6 m at a height of 3 m (or 1,8 m for the 3 m antenna distance) before descending to ground level or below. Other geometries are acceptable if they can be shown not to affect the measurements, or if the effects can be included in equipment calibration.

5.2.3.1 Height

For an antenna distance of 10 m, the centre of the antenna shall be 3,00 m ± 0,05 m above the ground/floor or water surface. For an antenna distance of 3 m, the height shall be 1,80 m ± 0,05 m.

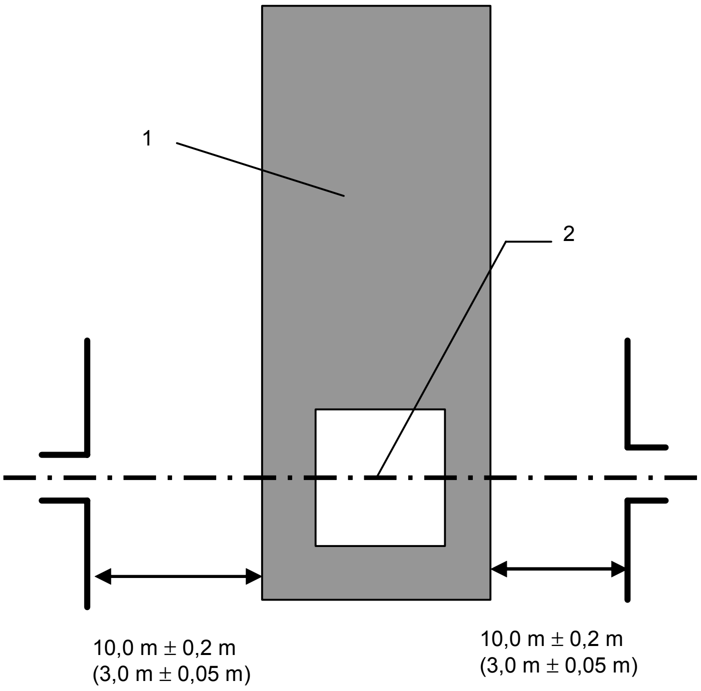


(Dimensions in brackets for 3 m antenna distance testing) Drawing not to scale

Key

1 Equipment under test

Figure 6 – Antenna position to measure emissions – Vertical polarization



(Dimensions in brackets for 3 m antenna distance testing) Drawing not to scale

Key

1 Equipment under test

2 Engine midpoint positioned on normal from antenna midpoint

Figure 7 – Antenna position to measure emissions – Horizontal polarization

5.2.3.2 Distance

The preferred horizontal distance between the reference point of the antenna and to the nearest metal part of the vehicle/boat/device shall be 10,0 m ± 0,2 m; as an alternative measurements may be made at a distance of 3,00 m ± 0,05 m, provided that the requirements of 5.2.3.4 are met.

5.2.3.3 Auxiliary (multiple) antennas

Auxiliary antennas are permitted, but if two antennas are facing each other, one shall be vertically polarized while the other is horizontally polarized.

The test site clear area requirement of 5.2.1.1 shall be applied also to the point midway between the vehicle/boat/device and the auxiliary antenna(s).

5.2.3.4 Multiple antenna positions (3 m antenna distance only)

Multiple antenna positions are required if the length of the vehicle or device is greater than the 3 dB beamwidth of the antenna. The same positions shall be used for both horizontal and vertical polarization measurements.

Multiple antenna positions can be avoided in the case where the measured emissions are lower than the original limit values minus a gain reduction calculated from the geometric dimensions of the test set-up and the antenna gain data (see Annex B).

NOTE A typical log periodic antenna has a 3 dB beamwidth of approximately 60°. This results in about 3,5 m of illumination at 3 m antenna distance, e.g. 1,75 m either side of the antenna centreline. Thus, a vehicle 8 m long requires three antenna positions on each side to quantify the radiation signature of that vehicle.

5.3 Test object conditions

5.3.1 General

Measurements made while the vehicle/boat/device is dry or made more than 10 min after precipitation has stopped falling are preferred. For outboard engines or propulsion motors and devices, all surfaces normally in contact with water while in use shall be exempt from the dryness criteria.

NOTE Dew or light moisture may seriously affect readings obtained on test objects having plastic enclosures.

For methods of evaluating compliance based on test object dryness see Clause 6.

5.3.2 Vehicles and boats

Measurements shall be made on the left and right sides of the vehicle or boat (see Figures 6 and 7).

All equipment which is automatically switched on together with the propulsion system shall be measured while operating in a manner which is as representative of normal operation as possible. The engine shall be at normal operating temperature.

For vehicles or boats with independent electric and internal combustion propulsion systems in the same vehicle or boat, the propulsion systems shall be tested separately.

Auxiliary engines shall be operated in their normal intended manner and tested separately from the main engine, if possible.

Depending upon the location of auxiliary engines, this requirement may dictate multiple tests of the vehicle or boat with the several engines successively positioned in front of the antenna during successive tests.

When tested separately, inboard, stern drive, and outboard engines or propulsion motors for boats shall be attached to a non-metallic board or non-metallic test fixture and tested in a way similar to that specified for boats with inboard engines/motors.

Measurements shall be made for two different operating conditions of vehicles and boats.

- "Key-On, Engine-Off” mode, and
- "Engine-Running” mode

These two operating conditions are applicable for vehicles/boats with an internal combustion engine and/or equipped with an electric propulsion motor (including hybrid propulsion systems)

5.3.2.1 "Key-On, Engine-Off" mode operating conditions

The "Key-On, Engine-Off" mode operating conditions are

- The ignition switch shall be switched on.
- The engine shall not be operating.
- The vehicle's electronic systems shall all be in their normal operating mode.

All equipment with internal oscillators >9 kHz or repetitive signals, which can be operated continuously, should be in normal operation.

5.3.2.2 "Engine-Running" mode operating conditions

Vehicles/boats with an internal combustion engine, shall be tested with the engine operated as shown in Table 3. The specified engine speed is the same for quasi-peak or peak measurements.

Table 3 – Internal combustion engine operating speeds

Number of cylinders	Engine speed min^{-1} ± 10 %
1	2 500 r/min
>1	1 500 r/min

Vehicles/boats equipped with an electric propulsion motor shall be tested with the vehicle driven on a dynamometer without a load, or on non-conductive axle stands, with a constant speed of 40 km/h, or the maximum speed, if this is less than 40 km/h

Vehicles with hybrid propulsion systems shall be tested with both the electrical and the internal combustion propulsion systems functioning to operate the vehicle at 40 km/h. If this is not possible, the vehicle shall be tested with the internal combustion engine operating at the speed defined in Table 3 and the electric propulsion system operating the vehicle at 40 km/h or the maximum speed if this is less than 40 km/h.

5.3.3 Devices

Measurements shall be made in normal operation position(s) and height(s), under normal full load and without load at idle speed, and in the direction of the maximum disturbance emission. Where practical, the device under test shall be measured in three orthogonal planes.

The operating conditions for devices ("Key-On, Engine-Off" mode and "Engine-Running" mode) shall be defined in the test plan.

Depending on the situation, the following conditions shall also be taken into account:

- if the operating position and height are variable, the device to be tested shall be so positioned that the spark-plug is 1,0 m ± 0,2 m above the ground;
- no operator shall be present, but, if necessary, a mechanical arrangement shall be made, using non-metallic material as far as possible, to keep the device in normal position(s) and at the specified engine speed.

5.4 Data collection

The entire required frequency range shall be measured. Spot frequency testing is only acceptable as used in 6.6, or for type approval purposes if the results of prior measurements covering the entire frequency range are available and prove compliance.

The results of average, quasi-peak and peak measurements shall be expressed in terms of dB (μV/m) for statistical evaluation.

The results of peak measurements shall be expressed in accordance with one of the bandwidths shown in Figure 2.

For peak detector measurements, the limits given in Figure 2 may be related to bandwidths other than 120 kHz or 1 MHz by adding a correction factor of 20 lg [bandwidth (kHz)/120 kHz] or 20 lg [bandwidth (MHz)/1 MHz].

6 Methods of checking for compliance with CISPR requirements

6.1 General

Some differences in the construction of vehicles/boats/devices are unlikely to have a significant effect on ignition noise emissions. For road vehicles, examples of such differences are given in Annex D.

6.2 Application of limit curves

6.2.1 Measurements under dry conditions

Certification measurements made while the vehicle/boat/device is dry (see 5.3.1), or made more than 10 min after the precipitation has stopped falling shall use the limit curves shown in Figures 2 and 3.

6.2.2 Measurements under wet conditions

If circumstances dictate that type approval measurements be made while precipitation is falling, or within 10 min after it has stopped, the vehicle/boat/device shall be deemed to comply with the requirements of this standard if the measured levels do not exceed a level of 10 dB below that shown in Figures 2 and 3.

In the event of any dispute concerning compliance, it shall be resolved by carrying out measurements under dry conditions.

Compliance based on good-faith wet measurements (and with the performance penalty mentioned above) shall remain valid until such time as it may be contested and dry measurements prove non-compliance. In such cases retrofitting of vehicles/boats/devices sold during the period when there was deemed compliance shall not be required.

When compliance is deemed on the basis of wet measurements, particular attention shall be paid to the surveillance of series production.

6.3 Evaluation (general)

For evaluation of a vehicle/boat/device the data from a complete scan shall be used.

For statistical analysis of multiple vehicles/boats/devices, the characteristic levels and calculation process of Annex A shall be used. The levels shall be compared to the limit at the representative frequency for the appropriate sub-band.

Statistical analysis of peak data from multiple vehicles/boats/devices shall be performed using data related to the same measurement bandwidth.

6.4 Type approval test

Compliance with the requirements given in Clause 4 shall be checked as follows:

6.4.1 Single sample

Measurements may be made on a prototype vehicle/boat/device of a later production series. The results shall be at least 2 dB below the limits specified in Clause 4.

6.4.2 Multiple samples (optional)

If optional multiple samples are tested, five or more additional vehicles/boats/devices shall be tested and the results combined with the data from the first test in 6.4.1. The result for each frequency sub-band shall be below the specified limits of Clause 4 at the representative frequency for that sub-band (see 6.3).

6.5 Surveillance (quality audit) of series production

6.5.1 Single sample

The results of the measurements on one vehicle/boat/device shall be a maximum of 2 dB above the specified limits of Clause 4.

6.5.2 Multiple samples (optional)

If optional multiple samples are tested, five or more additional vehicles/boats/devices shall be tested and the results combined with the data from the first test in 6.5.1. The results for each frequency sub-band shall be evaluated statistically, as described in Annex A; the result for each frequency sub-band shall be a maximum of 2 dB above the specified limit of Clause 4 at the representative frequency for that sub-band (see 6.3).

6.6 Quick prototype check for development testing (optional, quasi-peak detector emissions only)

An optional test using spot frequencies may be made to evaluate the approximate levels of emission of the vehicle/boat/device to determine whether the levels are likely to meet the limit of Clause 4. The spot frequencies to be used for specific measurements are the representative frequencies given in Annex A.

Annex A
(normative)

Statistical analysis of the results of measurements

A.1 Number of vehicles/boats/devices

The following condition shall be fulfilled in order to ensure, with an 80 % degree of confidence, that 80 % of mass-produced vehicles/boats/devices conform to a specified limit *L*:

$$\bar{x} + kS_n \leq L \tag{A.1}$$

where

$\bar{x}$ is the arithmetical mean of the results on n vehicles/boats/devices.

$$\bar{x} = \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right) \tag{A.2}$$

where

x_i is the individual result

k is the statistical factor dependent on *n*, as given by Table A.1

Table A.1 – Statistical factors

n	6	7	8	9	10	11	12
k	1,42	1,35	1,30	1,27	1,24	1,21	1,20

S_n is the standard deviation of results on *n* assembly line units.

$$S_n^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2 \tag{A.3}$$

S_n, x_i, $\bar{x}$ and *L* are expressed in identical logarithmic units (e.g. dB (µV/m), dB (µV), etc.).

If a first sample of *n* vehicles/boats/devices does not meet the specifications, a second sample of *N* vehicles/boats/devices shall be tested and all results assessed as coming from a sample of *n* + *N* vehicles/boats/devices.

NOTE See CISPR 16-3 for a more comprehensive discussion of statistical theory and application.

A.2 Frequency sub-bands for analysis

For analysis, the frequency range of 30 MHz to 1 000 MHz shall be divided into a minimum of 14 bands with approximately three bands in each octave (2:1 frequency ratio). For the regions where the limit is not constant (i.e. slopes), the ratio of the highest frequency to lowest frequency in each band shall be no greater than 1,34. See Table A.2 for an example of sub-bands.

A.3 Data collection

Each sub-band shall be scanned to determine its maximum emission level (i.e. the characteristic level). The characteristic levels for each sub-band shall be compared to the limit at the representative frequency for that sub-band, as determined by the methods of Clause 6.

Table A.2 – Example of frequency sub-bands

Frequency sub-band MHz	**Representative frequency** MHz
30 to 34	32
34 to 45	40
45 to 60	55
60 to 80	70
80 to 100	90
100 to 130	115
130 to 170	150
170 to 225	200
225 to 300	270
300 to 400	350
400 to 525	460
525 to 700	600
700 to 850	750
850 to 1 000	900

Annex B
(normative)

Procedure to determine an alternative emission limit for measurements at 3 m antenna distance

B.1 Calculate the maximum antenna angle $\alpha_{max.}$= maximum ($\alpha_{right;}$ α_{left}) from the vehicle dimensions, the antenna distance (vehicle surface – antenna reference point), and the antenna position (see Figure B.1).

Example: *d* = 3 m, vehicle length = 5 m, antenna centre line 1 m behind the front bumper, → $\alpha_{max.}$ = 53°.

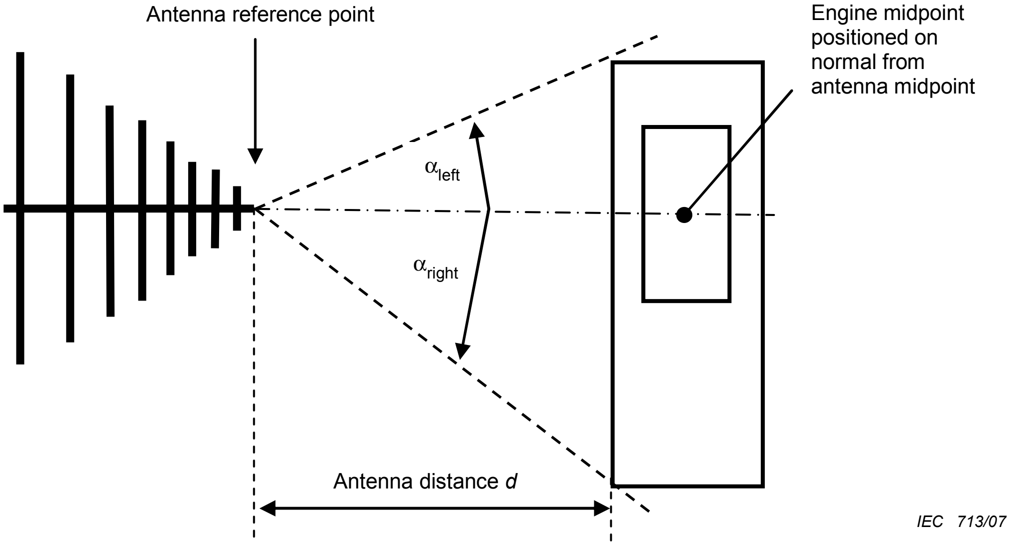


Figure B.1 – Determination of the maximum antenna angle

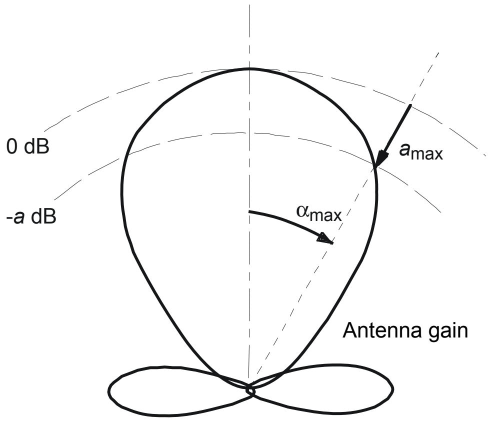
B.2 Read from the antenna directional pattern the gain reduction a_{max} at the maximum antenna angle α_{max} (see Figure B.2).

Because antennas have a frequency dependent gain, either the maximum gain reduction over the whole frequency range (typically at the highest frequency) has to be used or the gain attenuation shall be determined for a number of frequency steps. In each of those frequency sub-bands the local maximum gain reduction shall be used.

Example: for a log-periodic antenna (80 MHz to 1 000 MHz) and α_{max} = 53° this leads to a_{max} = 7 dB.

NOTE 1 Reference for the gain is the reference antenna (see 5.1.3.1)

NOTE 2 The radiation pattern provided from the manufacturer can be used unless visible damage of the antenna can be observed.



IEC 714/07

Figure B.2 – Calculation of the resulting gain reduction *a*

B.3 Calculate the alternative emission limit by subtracting from the original limit line the absolute value of the maximum gain reduction a_{max} calculated according to B.2.

Annex C
(informative)

Antenna and transmission line maintenance and characterization

C.1 Introduction

This annex contains, for guidance, an example of an antenna and transmission line characterization procedure that complies with the intent of 5.1.2. Proper antenna and transmission line characterization is essential to account for transmission line loss and mismatch errors, and to define the antenna factor for a broadband antenna, if used. Because coaxial cables used for transmission lines are subject to much wear and possible abuse, a suggested procedure is included to be used when cables require replacement.

This report is intended to be tutorial in nature, as an aid for those who may not be familiar with antenna and transmission line characterization. Other methods, such as those using tracking generators, network analysers, or narrowband signal sources may be equally satisfactory and nothing in this annex should be interpreted as precluding their use.

C.2 Maintenance

Characterization of antennas and cables as a combination or individually is at the option of the user. It is highly recommended, however, that they be characterized separately because:

- frequently, antennas are supplied without cables;
- any cable may be used with any antenna without need for characterization of the combination;
- cables are easier to characterize than antennas and almost any test facility can characterize them. Some laboratories may not be able to characterize complex antennas with their associated transmission lines easily;
- either the antenna or cable can be modified or replaced without need to characterize the other.

C.2.1 Periodic checks required

C.2.1.1 Cables

Checks should be made monthly, contingent upon whether the cables are handled or flexed frequently, or if they are exposed to sun and weather for long periods.

NOTE Even cables in conduits can develop problems, if temperature and humidity are uncontrolled.

C.2.1.2 Antennas

Because they are subject to less wear than cables, antennas may be checked less frequently, possibly only once or twice per year.

C.2.1.3 Physical examination

C.2.1.3.1 Cables

Serious kinks (very sharp bends), flat spots, abrasions, stretched spots, damaged connectors/braid, contamination of the inner insulation, or ageing of the cable shall require replacement and characterization.

C.2.1.3.2 Antennas

Broken elements or other obvious mechanical problems shall be corrected or parts replaced. Characterization is required.

C.2.1.4 Electrical examination

Antennas and cables shall be checked for higher loss and other problems periodically. If a characteristic such as loss has changed, the antenna, the cable, or the combination shall be characterized. Severe changes in characteristics may require replacement and characterization.

C.2.2 Cable and antenna characterization

The following requirements apply when the transmission line cable or antenna is replaced:

C.2.2.1 If the antenna factor data contains the loss and other characteristics of a specific cable in combination with the antenna, they shall be considered a matched pair. If either is replaced, the combination shall be characterized.

C.2.2.2 If the antenna and cable have been characterized separately with separate losses, etc. replacement of either shall require characterization only of that portion replaced.

C.3 Antenna characterization

Electric field strength shall be expressed in units of dB (µV/m). The relationship expressing electric field strength to the measurement system is:

$$F = R + AF + T \qquad \text{(C.1)}$$

where

F is the electric field strength in dB (μV/m);

R is the instrument reading in dB (μV);

AF is the antenna factor in dB (1/m), defined in Clauses C.5 or C.6.;

T is the transmission line factor in dB, defined in Clause C.7.

For broadband measurements, *F* and *R* are a function of the measuring instrument bandwidth.

C.4 Reference antenna

See 5.1.3.1.

C.5 Antenna factor

The factor relating the field strength at the reference point of the antenna to the loaded antenna terminal voltage (see Note 1) is called the antenna factor, designated *AF*, expressed in dB (1/m). The antenna factor shall include the effects of baluns, impedance matching devices, any mismatch losses, and operation outside the resonant frequency of the antenna.

NOTE 1 As this is a voltage ratio, the calculations to convert to decibels should be made using the factor of 20 lg of the ratio of the parameters.

NOTE 2 This factor is a function of frequency and is usually provided by manufacturers of resonant dipoles. Knowledge of the antenna factor for free space operation for resonant dipoles is sufficiently accurate for purposes of this international standard. Greater accuracy can be obtained by knowing the antenna factor for the particular resonant dipole being used in the test environment. A method for determining antenna factor is described in ANSI C63.5 (see C.14).

C.6 Alternate antennas

The antenna factor for the alternate antenna is the antenna factor for the reference antenna (resonant dipole) minus the gain (dB) of the alternate antenna relative to the reference antenna.

C.7 Transmission line

The transmission line factor (loss) shall be measured over the test frequency range. The factor is designated *T* and is:

$$T = 20\,\lg\left(\frac{\mathit{input\ voltage}}{\mathit{output\ voltage}}\right) \quad \text{dB} \qquad \text{(C.2)}$$

NOTE It is recommended that the transmission line be double braided or solid shielded coaxial cable to achieve proper shielding. It is permissible that transmission line loss and mismatch errors be accounted for by including the cable in the measuring instrument calibration. When this is done, *T* is dropped from equation (C.1) for *F*.

C.8 Alternate antenna characterization instrumentation

The prime function of the characterization instrumentation is to provide a repeatable RF field for the comparison of an alternate antenna to the reference dipole antenna.

C.8.1 Characterization signal generator

A measuring instrument with a built-in tracking generator or a network analyser or a signal generator together with a measuring instrument shall be used for alternate antenna characterization.

The output of the characterization signal generator shall be known to within ±1,0 dB. The characterization signal generator shall be capable of creating an electric field at least 6 dB above the least measurable field strength of the measuring instrument. A value of at least 10 dB is preferred.

A less accurate characterization signal generator is the impulse generator.

NOTE 1 If a broadband impulse generator is used, it should be capable of producing an uniform spectrum to within ±3,0 dB in the frequency range 30 MHz to 1 000 MHz.

NOTE 2 Experience indicates that an impulse generator that has a nominal 100 dB (µV/kHz) level can produce a field of approximately 10 dB (µV/m/kHz) at the receiving antenna when a 10 dB impedance matching attenuator is used at the output of the generator. This field strength varies depending on transmitting antenna losses and radiation characteristics and on propagation anomalies. This approximate value is provided so that the antenna factor determination can be performed. It is then possible to estimate the required sensitivities and the tolerable losses in the measuring system.

C.8.2 Transmitting antenna

For ease in measurement and to assure freedom from variation caused by antenna adjustment, it is recommended that broadband antennas be used. Typical antennas are the biconical for 30 MHz to 200 MHz, and the log periodic for 200 MHz to 1 000 MHz.

C.9 Alternate antenna factor determination

If an alternate antenna (see Clause C.6) is used, the antenna factor shall be determined by a substitution technique in the intended test environment. The reference shall be the dipole (see Clause C.4). The radiated field to be measured for the substitution technique is generated by the transmitting antenna and the characterization signal generator as specified in Clause C.8.

NOTE Error factors associated with this procedure include non-linearity of the measuring instrument, influence of the surroundings on the reference antenna and possible change in location of the alternate antenna phase centre relative to that of the reference antenna.

C.10 Test geometry

The alternate antenna shall be located at its intended test position. When substitution occurs, the dipole shall be placed so that its reference point is placed at the precise place that the reference point for the alternate antenna normally occupies. The reference point of the antenna is defined as:

- the phase centre (mid-point) for a dipole antenna,
- the phase centre (mid-point) for a biconical antenna,
- the tip or any specific point along the longitudinal axis for an antenna with log-periodic elements (including biconilog antennas).

C.10.1 The transmitting antenna shall be 10 m in horizontal distance from the alternate antenna reference point in Figure C.1 (taking the place of the nearest vehicle periphery) and shall be 1 m high.

C.10.2 For the 3 m antenna distance, the transmitting antenna shall be 3 m in horizontal distance from the alternate antenna, as in Figure C.1.

C.11 Test procedure

The procedure to be used is to measure the reference field with the reference antenna positioned as in Clause C.10 to obtain a meter reading (usually voltage). Then the alternate antenna is substituted and a second reading is taken.

The antenna factor for the alternate antenna is calculated as discussed in Clause C.6. This procedure should be conducted for both horizontal and vertical polarizations to determine whether different antenna factors are required for each of the two cases.

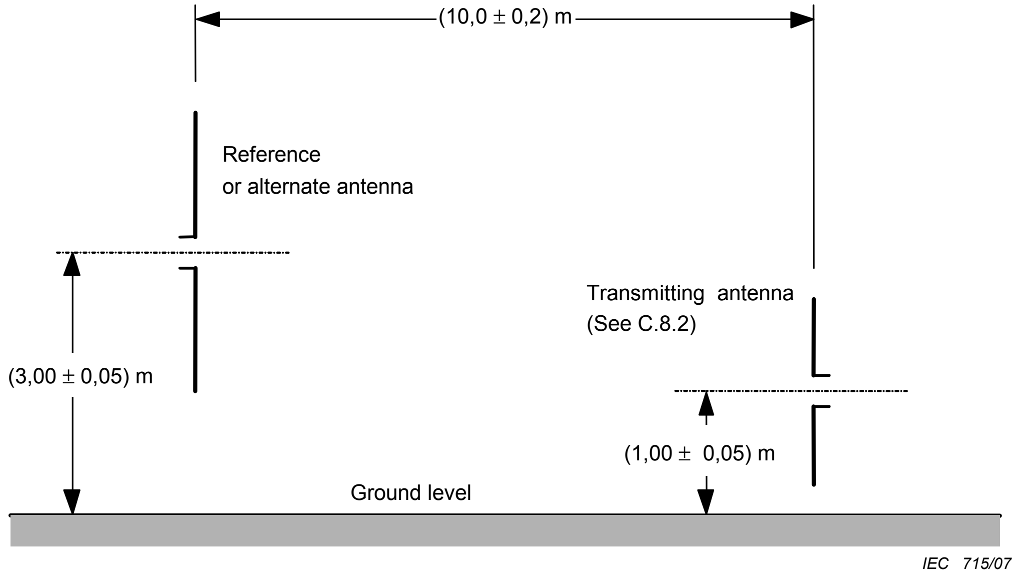
NOTE The antenna factor of the reference antenna may be assumed to be the same for both polarizations.

C.12 Frequencies

The number of frequencies at which antenna factor values are required depends on the alternate antenna being evaluated. A sufficiently large number of frequencies shall be considered to describe the function adequately.

C.13 Complete system verification

The complete measurement system comprised of antenna, transmission cable, measuring instrument and readout devices shall be verified by measuring an electric field established with the characterization signal generator and antenna(s) described in C.8. This verification shall be made on a periodic basis so that any change in system performance can be detected (see Figure C.1).



Drawing not to scale

NOTE For 3 m antenna distance the 10,0 m ± 0,2 m horizontal dimension changes to 3,00 m ± 0,05 m; the 3,00 ± 0,05 m vertical dimension changes to 1,80 m ± 0,05 m.

Figure C.1 – Alternate antenna factor determination (10 m antenna distance)

C.14 Reference document

ANSI C63.5, *American National Standard for Electromagnetic Compatibility – Radiated Emission Measurements in Electromagnetic Interference (EMI) Control – Calibration of Antennas (9 kHz to 40 GHz). American National Standards Institute, 11 West 42nd Street, New York, NY 10036, USA.*

Annex D
(informative)

Construction features of motor vehicles affecting the emission of ignition noise

D.1 Introduction

For guidance in testing and approval, it should be noted that some differences in vehicle construction are unlikely to have a significant effect on the ignition noise emission. For this reason, measurements on one variant may be considered as being typical and such a variant may be used as the basis for the assessment of the design characteristics of road vehicles insofar as they affect the ignition noise emission.

D.2 The following construction differences have little effect on ignition noise emission.

NOTE This is not all-inclusive, it is a set of examples only.

a) Two-door or four-door vehicles or station-wagons of similar overall length.
b) Differences in radiator grille construction provided that grilles are of metal, offer approximately the same proportion of clear opening and have approximately the same mounting.
c) Shape of fenders or contour of hood/bonnet.
d) Different size wheels or tires.
e) Ordinary non-resistive spark-plugs of different makes, provided they have equivalent electrical characteristics (capacitance, inductance, resistance).
f) Coils and distributors of different makes, provided they have equivalent electrical characteristics (capacitance, inductance, resistance).
g) Decorative ornamentation, heaters or air conditioners, occupying the same location.
h) Ordinary resistive spark-plugs of different heat ranges, provided they have equivalent electrical characteristics (capacitance, inductance, resistance).
i) Size, shape, and location of the ancillary electrical equipment (including its harness), which is needed to run the engine.

D.3 The following construction differences can be expected to have a significant effect on ignition noise emission.

NOTE This is not all-inclusive, it is a set of examples only.

a) Significant differences in compression ratio.
b) Use of plastic or metallic fenders, roofs or body panels.
c) Size, shape, and location of metallic air cleaners and use of plastic rather than metallic air cleaners or vice-versa.
d) Location of ignition components on the engine or in the engine compartment.
e) Size and shape of the engine compartment and location of the high-voltage harness.
f) Significant differences in the clear opening of engine compartment around the wheels.
g) Right or left hand steering as it may affect the position of the other components or parts.
h) Vehicles having auxiliary engine(s) for purposes other than propulsion.

Annex E
(informative)

Measurement of the insertion loss of ignition noise suppressors

E.1 Introduction

Two methods of measurement of the insertion loss of ignition noise suppressors are used.

E.1.1 CISPR box method (50/75 Ω laboratory method)

This method is described in Clause E.3.

E.1.2 Field comparison method

In this method, the insertion loss of the suppressor (or set of suppressors) is determined from the measurement of interference field strength caused by the vehicle/boat/device on the open test site. It is evaluated according to the formula:

$$A = E_1 - E_2 \tag{E.1}$$

where:

E_1 is the field strength caused by the ignition system without suppressors, expressed in dB (μV/m);

E_2 is the field strength caused by the same ignition system but with suppressors (or set of suppressors) expressed in dB (μV/m).

NOTE Field strength is to be measured in accordance with Clause 5.

E.2 Comparison of test methods

E.2.1.1 CISPR box method

With the help of the CISPR box method, it is possible to compare only the characteristics of single suppressors of the same kind under standard laboratory conditions. At present, this method is used in the frequency range from 30 MHz to 300 MHz. Results obtained have no significant correlation with the efficiency of suppressors observed in practice. This method does not allow measurement of a set of suppressors consisting, for example, of four resistors and five cables with distributed attenuation. Nevertheless, it provides a means of quick control, for instance of suppressors during manufacture after previous verification of their effectiveness in actual conditions.

E.2.2 Field comparison method

The field comparison method may be considered the reference method since the results obtained give the insertion loss of suppressors observed in practice. It automatically takes into account all the factors influencing the insertion loss and it has no limitations in frequency range. Its main disadvantage is the need to perform measurements on an open test-site (or in an absorber lined shielded enclosure as specified in 5.2.2) and the need to test the complete vehicle/boat/device.

E.3 CISPR box method (50/75 Ω laboratory method of measurement of insertion loss of ignition noise suppressors)

E.3.1 General conditions and limitations of measurement

The insertion loss of an ignition noise suppressor is measured with the test circuit shown in Figure E.1. This method is intended to be used only as a comparative method for suppression devices of the same type and is not intended to give direct correlation with emission measurements.

E.3.2 Test procedure

In Figure E.1, the coaxial switches (2) are adjusted so that the signal from the signal generator (1) is passed through the test box (4) and the specimen under test (5) giving an indication on the output indicator of the measuring instrument (7). Fixed "T" attenuators (3) have a loss of 10 dB.

The coaxial switches (2) are then turned so that the signal passes through the calibrated variable attenuator (6), which is adjusted to give the same indication on the output indicator of the measuring instrument (7). The insertion loss of the ignition noise suppressor is then given by the attenuation read on the calibrated variable attenuator (6) minus the attenuation of the fixed attenuators (3).

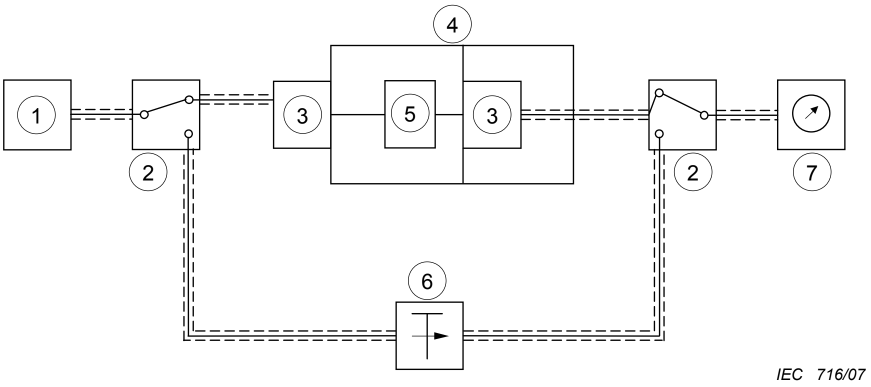
E.3.3 Test box construction

Details of the usual test box are shown in Figures E.2 to E.4. For the majority of applications, this box is applicable: however, hole positions and box size may require modification for some applications. The arrangement of the suppressors in the test box is shown in Figures E.5 to E.11. All non-coaxial connecting leads within the CISPR box to the suppressors under measurement shall be kept as short as possible, or of specified length where shown. In all arrangements the spark-plug is modified to accept a coaxial input and is constructed from a standard spark-plug assembly having a direct connection between the spark-plug terminal and the central electrode.

E.3.4 Results

For ignition noise suppressors having a high impedance, the insertion loss a_1 in a circuit having a characteristic impedance z_1 can be converted to the insertion loss a_2 in a circuit having a characteristic impedance z_2; the following formula applies:

$$a_2 = a_1 + 20 \lg (z_1/z_2). \qquad \text{(E.2)}$$



Key

①	Signal generator	⑤	Specimen under test
②	Coaxial switch	⑥	Calibrated variable attenuator
③	Fixed ”T” attenuator (10 dB)	⑦	Measuring instrument
④	Test box		

Items ①, ②, ③, ⑥ and ⑦ shall have the same characteristic impedance.

Figure E.1 – Test circuit

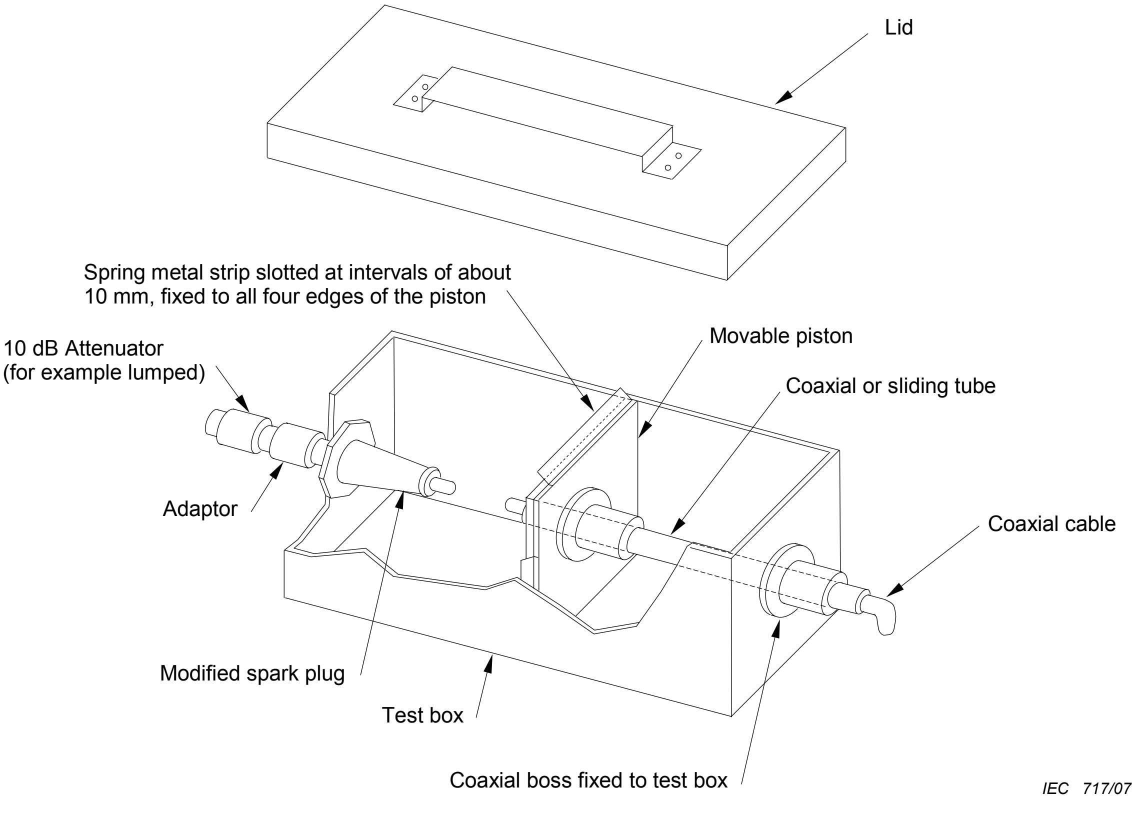
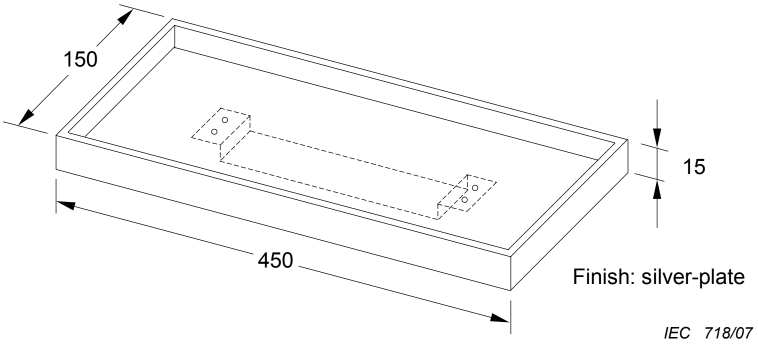

Lid
Spring metal strip slotted at intervals of about 10 mm, fixed to all four edges of the piston
10 dB Attenuator (for example lumped)
Movable piston
Coaxial or sliding tube
Adaptor
Coaxial cable
Modified spark plug
Test box
Coaxial boss fixed to test box
IEC 717/07

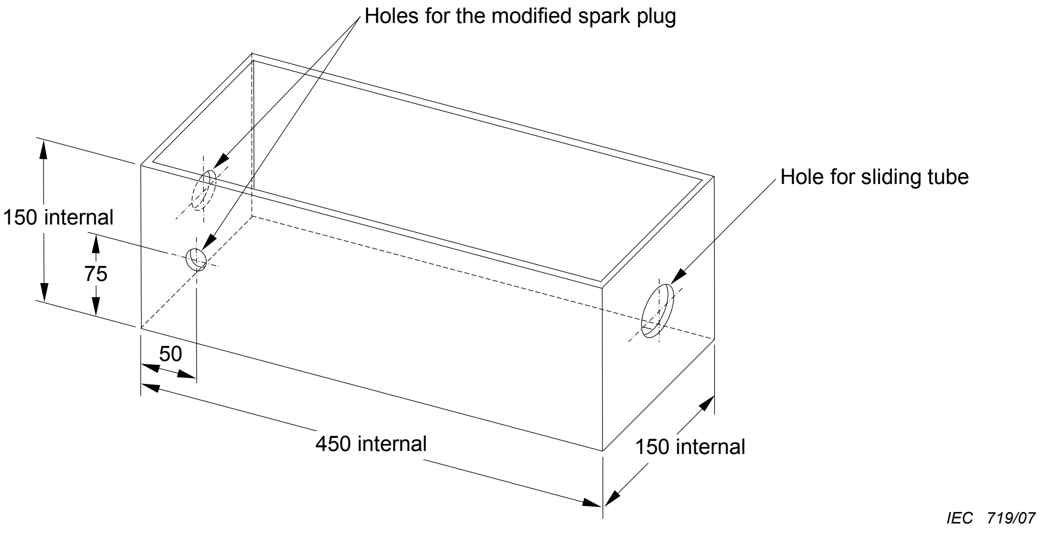
Figure E.2 – General arrangement of the test box



Dimensions in millimetres

NOTE Lid made to give U-shaped overlapping push fit onto upper face of the test box.

Figure E.3 – Details of the test box lid



Dimensions in millimetres

Figure E.4 – Details of the test box

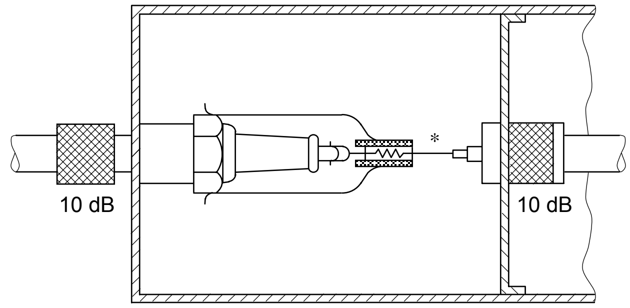


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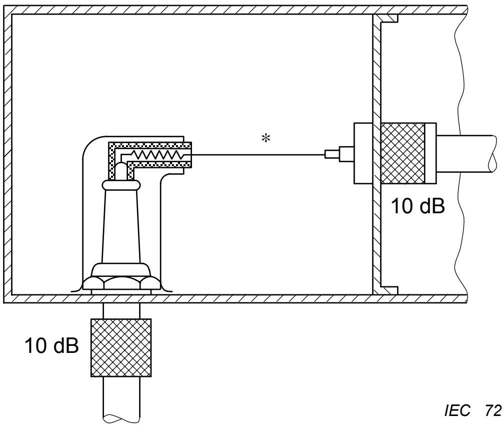
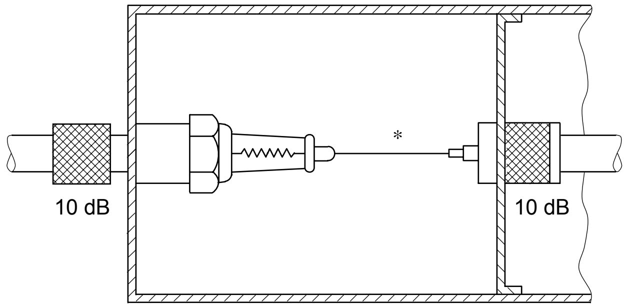
Figure E.5 – Straight spark-plug ignition noise suppressor (screened or unscreened)



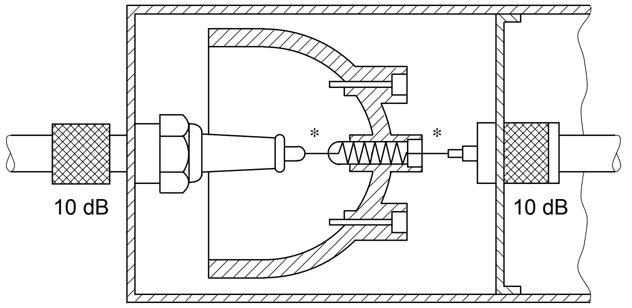
IEC 721/07

Figure E.6 – Right-angle spark-plug ignition noise suppressor (screened or unscreened)



IEC 722/07

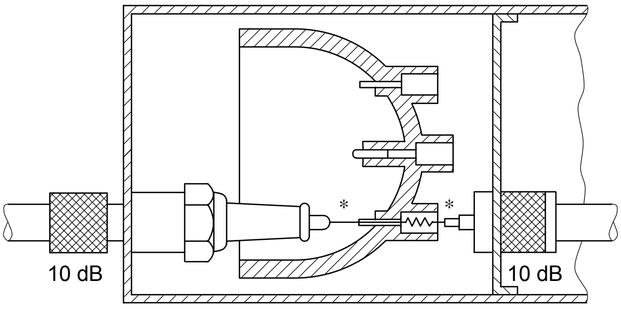
Figure E.7 – Noise suppression spark-plug



IEC 723/07

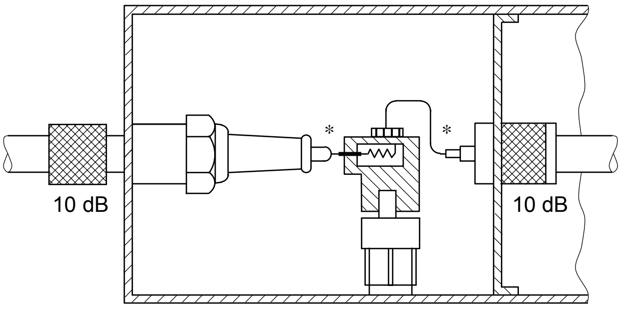
Figure E.8 – Resistive distributor brush

* All connecting leads to noise suppressors under measurement to be kept as short as possible or of specified length where shown.



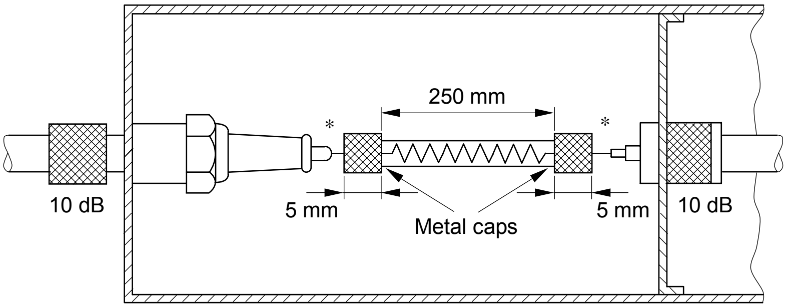
IEC 724/07

Figure E.9 – Noise suppressor in distributor cap



IEC 725/07

Figure E.10 – Noise suppression distributor rotor



IEC 726/07

Figure E.11 – Noise suppression ignition cable (resistive or reactive)

* All connecting leads to suppressors under measurement to be kept as short as possible or of specified length where shown.

Annex F
(informative)

Methods of measurement to determine the attenuation characteristics of ignition noise suppressors for high voltage ignition systems

F.1 Introduction

This annex specifies test methods for the evaluation of the efficiency of ignition noise suppressors used in the high-voltage part of ignition systems of internal combustion engines, such as suppressive HV connectors, resistive spark-plugs.

The frequency range is 30 MHz to 1 000 MHz.

F.2 Recommended requirements for ignition noise suppressors

The required limit class(es) for noise suppressors shall be defined by the users of this standard based on the values in Table F.1.

NOTE At the transition frequencies the higher attenuation should be considered as a limit.

Table F.1 – Limits

Class	**Range I** **30 MHz – 70 MHz**	**Range II** **70 MHz – 200 MHz**	**Range III** **200 MHz - 500 MHz**	**Range IV** **500 MHz - 1 000 MHz**
	Attenuation dB			
1	6	14	8	6
2	12	20	14	12
3	18	26	20	18
4	24	32	26	24
5	30	38	32	30
6	36	44	38	36

F.3 Test set-up

The test set-up is shown in Figures F.1 and F.2.

The measurement is performed with a measuring instrument and an absorbing clamp according to CISPR 16-1-3.

The RF measuring instrument is set to quasi-peak measurement.

NOTE 1 Since the ignition disturbance is of a broadband nature and the system resonances have been minimized by use of the absorbing clamp, the frequency range need not be scanned continuously – it may be stepped (e.g. logarithmically) instead.

The peak voltage, measured at the ignition coil output, shall be set to 10 kV by adjusting the inert gas pressure in the pressure chamber. The amplitude for the pulses shall be as constant as possible. The pulse frequency shall be 50 Hz. The measuring distance *a* shall be 150 mm if no other values are specified in the examples of Clause F.5.

NOTE 2 Protection against high voltages – The energy of modern transistorized ignition systems is so high that touching the low-voltage side may create dangerous currents in a human body. Protection against high-voltage hazards is necessary.

NOTE 3 Protection of the absorbing clamp – The insulation of the ignition cable through the absorbing clamp may not be sufficient for this application. The ignition cable must therefore be housed within the absorbing clamp in insulating pipes.

In order to stabilize the spark discharge and thus the RF spectrum it is recommended to ventilate the pressure chamber (refer to Figure F.3).

A lateral minimum distance to metallic parts (e.g. walls) of 400 mm shall be maintained.

If the set-up is constructed using different parts of sheet metal, good electrical connection between the different parts shall be ensured.

The ground strap shall have a minimum cross-sectional area of 5 mm^2, a minimum width of 8 mm and a maximum length of 1 200 mm.

The connections of the EUT to the measuring equipment shall be as close to reality as possible.

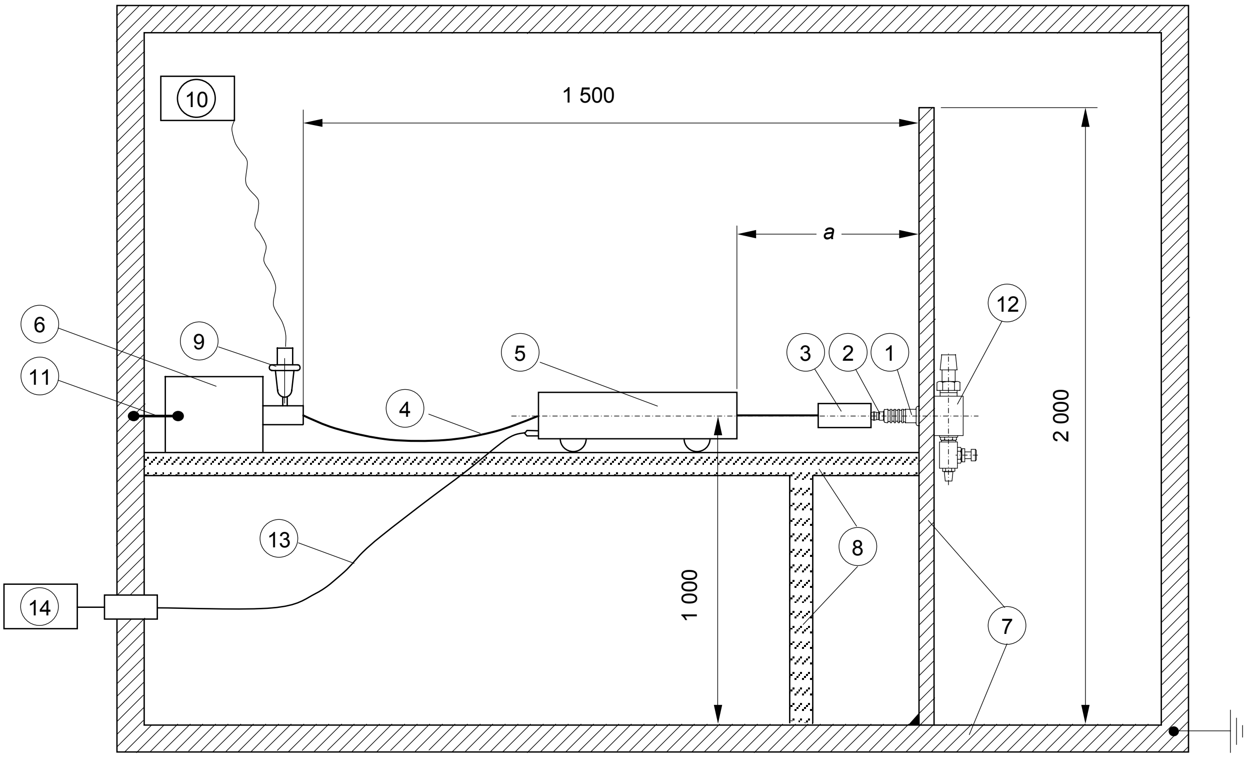
F.4 Test procedure

Install a measuring spark-plug as defined in Clause F.5.

The RF disturbance power is first measured without ignition noise suppressors, then the measurement is repeated with the ignition noise suppressors inserted.

NOTE Overload protection of the measuring instrument input – During recording the situation without ignition noise suppression, pulses of about 1 kV reach the measuring instrument input. This may destroy the measuring instrument. The use of a 20 dB attenuator with sufficient voltage/pulse resistance avoids this problem.

The difference between both measurements is the insertion loss of the ignition noise suppression device.



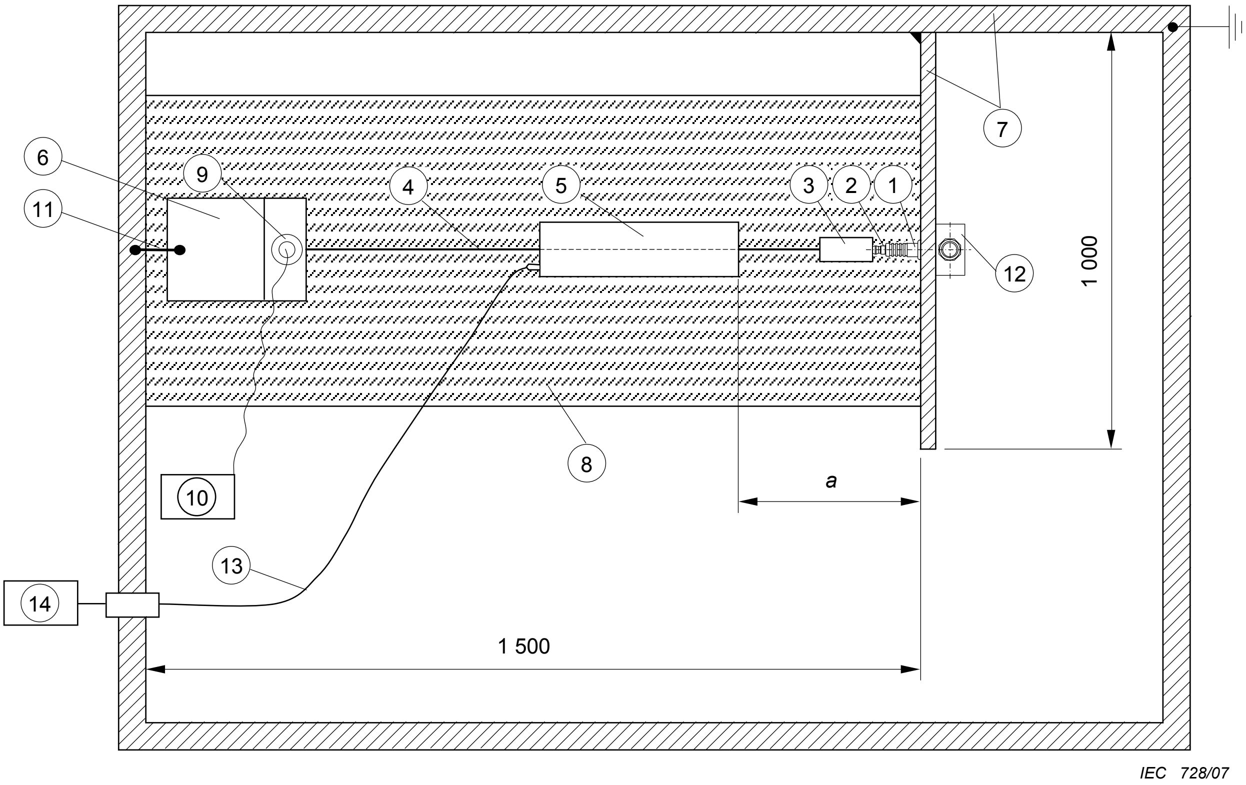
IEC 727/07

Dimensions in millimetres

Key

1	Spark-gap provided by a measuring spark-plug according to F.5
2	Connection to the spark-plug
3	EUT
4	HV ignition cable, not shielded and without suppressive elements
5	Absorbing clamp
6	Transistorized ignition coil system with power supply and pulse frequency generator (negative terminal connected to ground)
7	Wall and floor sheet metal
8	Table and supports, non-metallic
9	HV probe
10	Peak-voltage measuring instrument (e.g. oscilloscope)
11	Ground strap
12	Pressure chamber with ventilation according to F.3
13	Measuring cable
14	RF disturbance measuring instrument
a	is the measuring distance (see F.3).

Figure F.1 – Test set-up, side view



Dimensions in millimetres

Key

1 Spark-gap provided by a measuring spark-plug according to F.5

2 Connection to the spark-plug

3 EUT

4 HV ignition cable, not shielded and without suppressive elements

5 Absorbing clamp

6 Transistorized ignition coil system with power supply and pulse frequency generator (negative terminal connected to ground)

7 Wall and floor sheet metal

8 Table and supports, non-metallic

9 HV probe

10 Peak-voltage measuring instrument (e.g. oscilloscope)

11 Ground strap

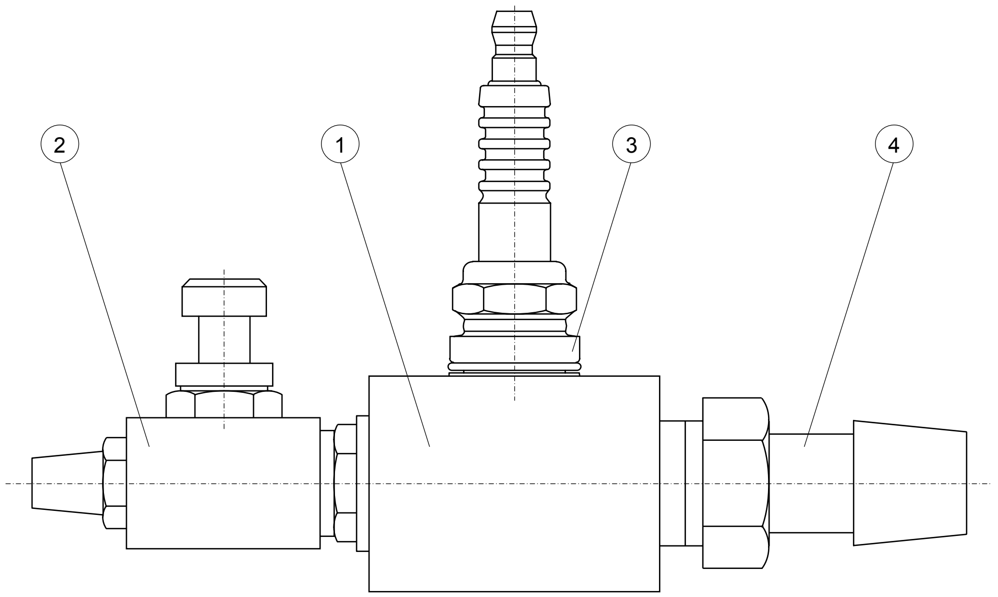
12 Pressure chamber with ventilation according to F.3

13 Measuring cable

14 RF disturbance measuring instrument

a is the measuring distance (see F.3).

Figure F.2 – Test set-up, top view

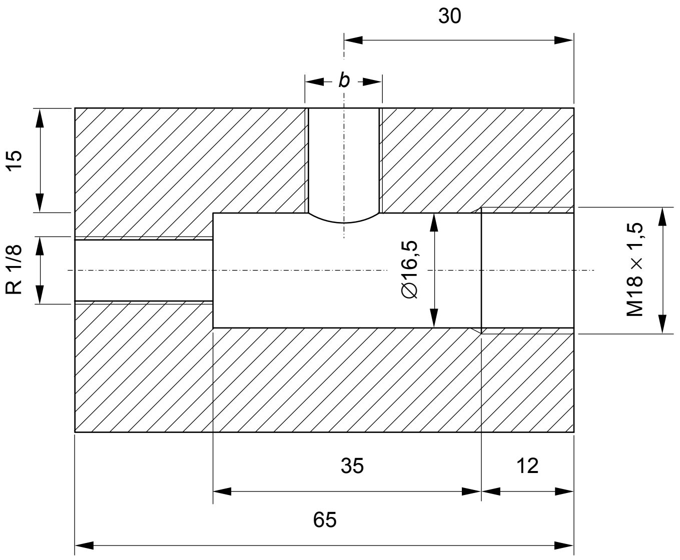


IEC 729/07

Key

1	Pressure chamber
2	Throttle valve with attenuator (ventilation requirements to be evaluated empirically)
3	Measuring spark-plug
4	Connection for oil- and waterfree pressurized inert gas

Figure F.3a – General view



IEC 730/07

Dimensions in millimetres

b = M10 × 1, M12 × 1,25, or M14 × 1,25

Values not specified may be selected by the manufacturer

Material: metal

Figure F.3b – Cross-sectional view

Figure F.3 – Pressure chamber with ventilation

F.5 Measuring spark-plugs without suppression elements

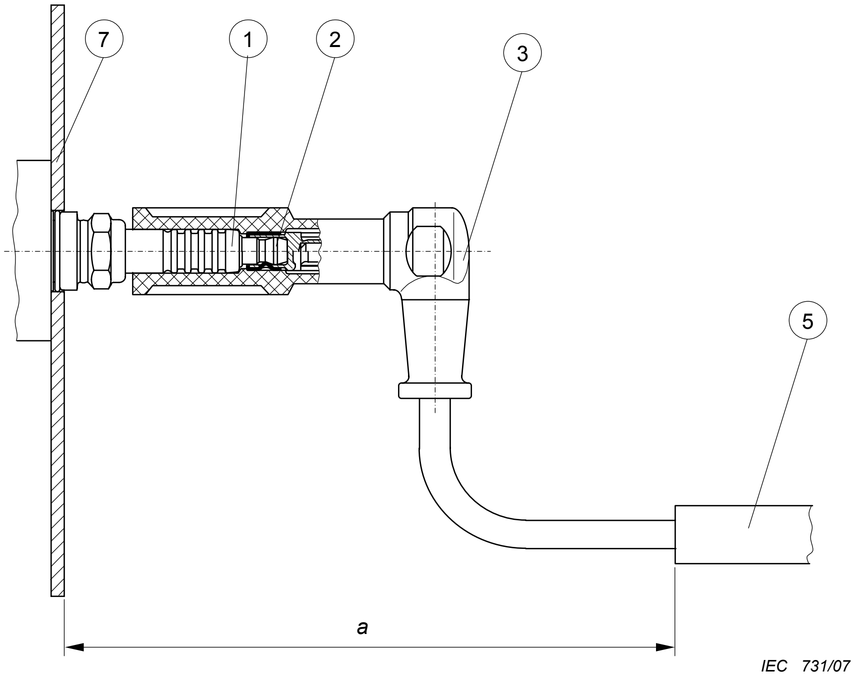
A measuring spark-plug shall be used to evaluate ignition noise suppressors, designed as part of the spark-plug assembly or by some other technique (for example, resistive ignition cables).

All spark-plugs without ignition noise suppression according to the relevant standards ISO 1919, ISO 2344, ISO 2704 and ISO 2705 may be used. The electrode gap shall be adjusted to 0,7 mm ± 0,1 mm.

F.6 Test set-up examples

Because of the high variety of different geometrical dimensions of suppression elements, the connection (see item 2 in Figure F.4, for example) shall be agreed between manufacturer and user.

F.6.1 Connection of a right-angle spark-plug ignition noise suppressor



Dimensions in millimetres

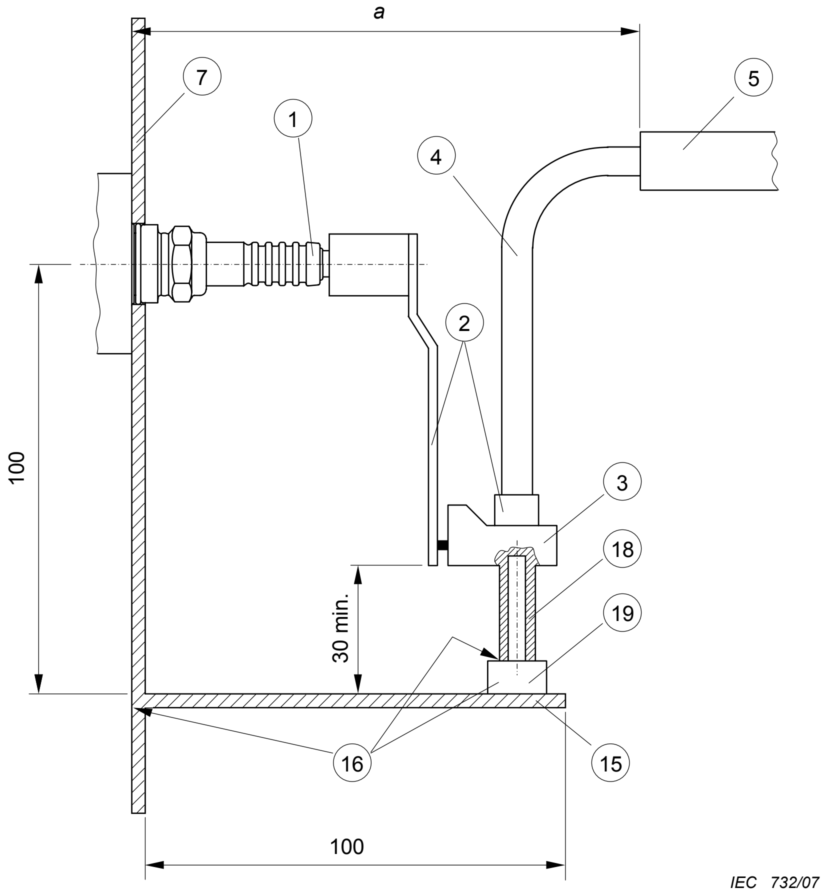
Key

1	Spark-gap provided by a measuring spark-plug according to F.5
2	Connection
3	EUT
5	Absorbing clamp
7	Wall sheet metal
a	is the measuring distance (see F.3)

NOTE The HV ignition cable to the absorbing clamp must be as short as possible.

Figure F.4 – Top view of the set-up of a right-angle ignition noise suppressor for distributors

F.6.2 Connection of a distributor rotor



Dimensions in millimetres

Key

1 Spark-gap provided by a measuring spark-plug according to F.5

2 Connection

3 EUT

4 HV ignition cable, not shielded and without suppressive elements

5 Absorbing clamp

7 Wall sheet metal

15 Metallic ground plane

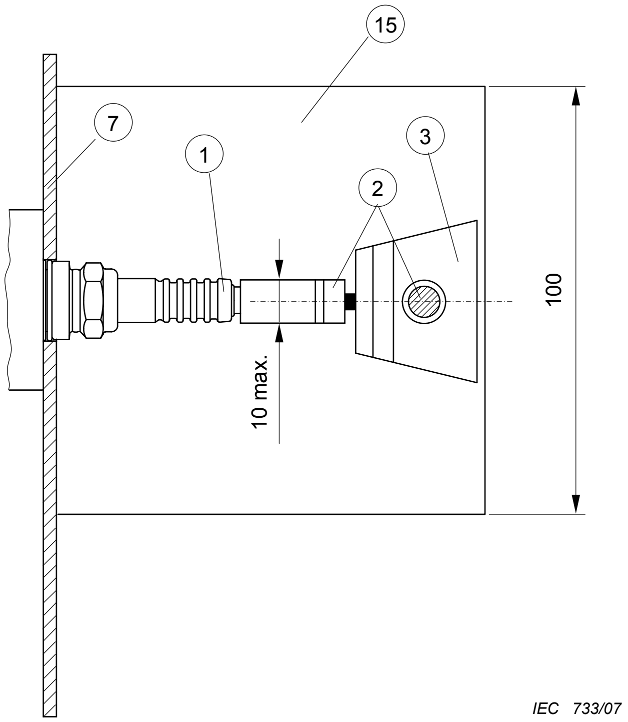
16 Wall sheet metal (7), ground plane sheet metal (15), adaptor part (19) and original shaft end (18) well connected electrically and in terms of RF

18 Original shaft end

19 Adaptor part

a is the measuring distance (see F.3)

Figure F.5 – Location of high voltage ignition components



IEC 733/07

Dimensions in millimetres

Key

1 Spark-gap provided by a measuring spark-plug according to F.5

2 Connection

3 EUT

7 Wall sheet metal

15 Metallic ground plane

Figure F.6 – Top view of the test set-up for distributor rotors

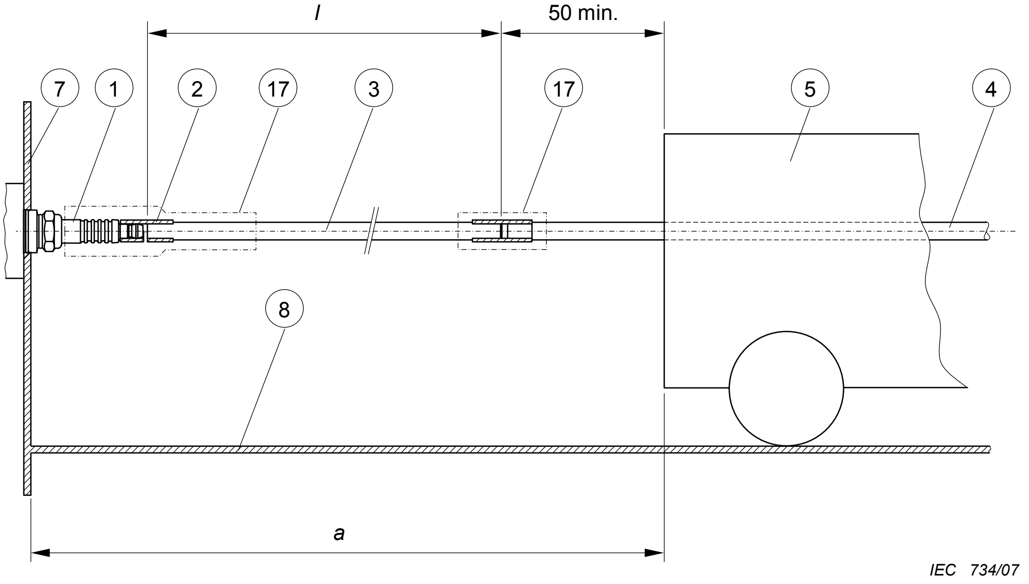
F.6.3 Connection of distributor caps with integrated ignition noise suppressors

Because of the high variety of different geometrical dimensions of distributor caps, the complete test set-up shall be agreed upon between manufacturer and user.

F.6.4 Connection of resistive ignition cables

F.6.4.1 Ready-to-use resistive ignition cables

Ready-to-use ignition cables shall be measured with their original length *l*; the measuring distance shall be chosen as $a = l + 120$ mm. The connection between the EUT and the non-suppressive HV ignition cable shall be protected by insulating material against touching. Its minimum distance to the absorbing clamp shall be 50 mm.



Dimensions in millimetres

Key

1	Spark-gap provided by a measuring spark-plug according to F.5
2	Connection
3	EUT
4	HV ignition cable, not shielded and without suppressive elements
5	Absorbing clamp
7	Wall sheet metal
8	Table and supports, non-metallic
17	Protective insulation and ready-to-use protective cap
a	is the measuring distance (see F.6.4.1)
l	is the length of the ready-to-use resistive ignition cable

Figure F.7 – Side view of the test set-up for ready-to-use resistive ignition cables

F.6.4.2 Resistive ignition cables not ready-to-use

These cables shall be measured preferably with a measuring distance of a = 0,5 m.

The length of the EUT is measured from the connection (item 2 in Figure F.1) to the ignition system (item 6 in Figure F.1).

F.7 Reference documents

ISO 1919:1998, *Road vehicles – M14 × 1,25 spark-plugs with flat seating and their cylinder head housings*

ISO 2344:1998, *Road vehicles – M14 × 1,25 spark-plugs with conical seating and their cylinder head housings*

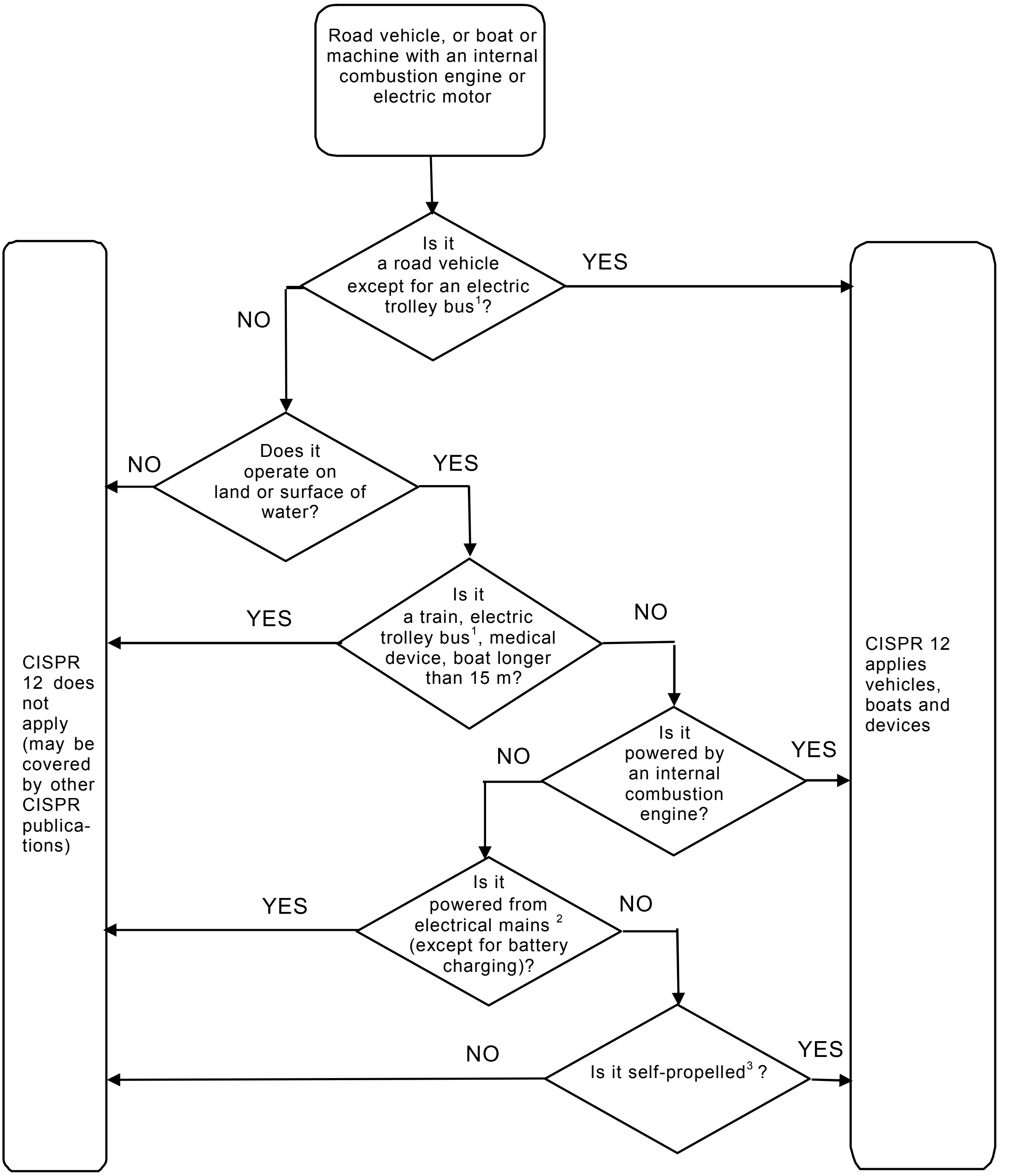
ISO 2704:1998, *Road vehicles – M10 × 1 spark-plugs with flat seating and their cylinder head housings*

ISO 2705:2006, *Road vehicles – M12 × 1,25 spark-plugs with flat seating and their cylinder head housings*

Annex G
(informative)

Flow chart for checking the applicability of CISPR 12

This chart is intended to assist with determining whether a particular product is covered by this international standard. In case of conflict between this chart and Clause 1, Clause 1 shall take precedence.


Road vehicle, or boat or machine with an internal combustion engine or electric motor
Is it a road vehicle except for an electric trolley bus1?
YES
NO
Does it operate on land or surface of water?
NO
YES
Is it a train, electric trolley bus1, medical device, boat longer than 15 m?
YES
NO
Is it powered by an internal combustion engine?
NO
YES
Is it powered from electrical mains 2 (except for battery charging)?
YES
NO
Is it self-propelled3 ?
NO
YES
CISPR 12 does not apply (may be covered by other CISPR publica-tions)
CISPR 12 applies vehicles, boats and devices

IEC 2254/08

[1] In the case of a dual-mode trolley bus (e.g. propelled by power from either a.c./d.c. mains or an internal combustion engine), the a.c./d.c. mains portion of the vehicle propulsion system shall be excluded from this standard.

[2] Connection to the electrical mains is the work of another CISPR subcommittee.

[3] Automatic battery powered cleaners are the work of another CISPR subcommittee.

Annex H
(informative)

Items under consideration

H.1 Introduction

This annex contains future work items that are under consideration.

H.2 Frequency range

As further work progresses in CISPR A and CISPR H, this will be reviewed and CISPR 12 updated accordingly.

H.3 Measurement uncertainty

This topic will be considered for future revisions of this standard.

H.4 Operation conditions for electrically driven boats

As sufficient experience is available on this topic, it will be included in CISPR 12.

H.5 Necessity of Annexes E and F

For the next edition of CISPR 12, consideration will be given to removing Annexes E and F if there is no further need for them within the industry.

H.6 Correlation between OTS and ALSE measurements

A method needs to be defined for future editions of this document.

Bibliography

CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus* 1)

CISPR 16-3, 2003: *Specification for radio disturbance and immunity measuring apparatus and methods – Part 3: CISPR technical reports*
Amendment 1 (2005)
Amendment 2 (2006)

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1) Withdrawn in 2003 and replaced by documents CISPR 16-1-1 to CISPR 16-1-5.

AMENDMENT NO. 1

1 Scope

Replace the text of item c) by the following:

c) devices equipped with internal combustion engines or traction batteries (see 3.3).

Replace the fourth paragraph as follows:

This standard does not apply to aircrafts, household appliances, traction systems (railway, tramway and electric trolley bus), or to incomplete vehicles. In the case of a dual-mode trolley bus (e.g. propelled by power from either a.c./d.c. mains or an internal combustion engine), the internal combustion propulsion system shall be included, but the a.c./d.c. mains portion of the vehicle propulsion system shall be excluded from this standard.

3 Terms and definitions

Replace the existing definition and note 3.1 by the following new definition and note:

3.1
vehicle
machine operating on land which is intended to carry persons or goods

NOTE Vehicles include, but are not limited to, cars, trucks, buses, mopeds, agricultural machinery, earth-moving machinery, material-handling equipment, mining equipment, floor treatment machines and snowmobiles.

Replace the existing definition and note 3.3 by the following new definition and note:

3.3

device

machine driven by an internal combustion engine which is not primarily intended to carry persons or goods

NOTE Devices include, but are not limited to, chainsaws, irrigation pumps, snow blowers, air compressors, walk-behind floor treatment machines and landscaping equipment.

Add the following new definition:

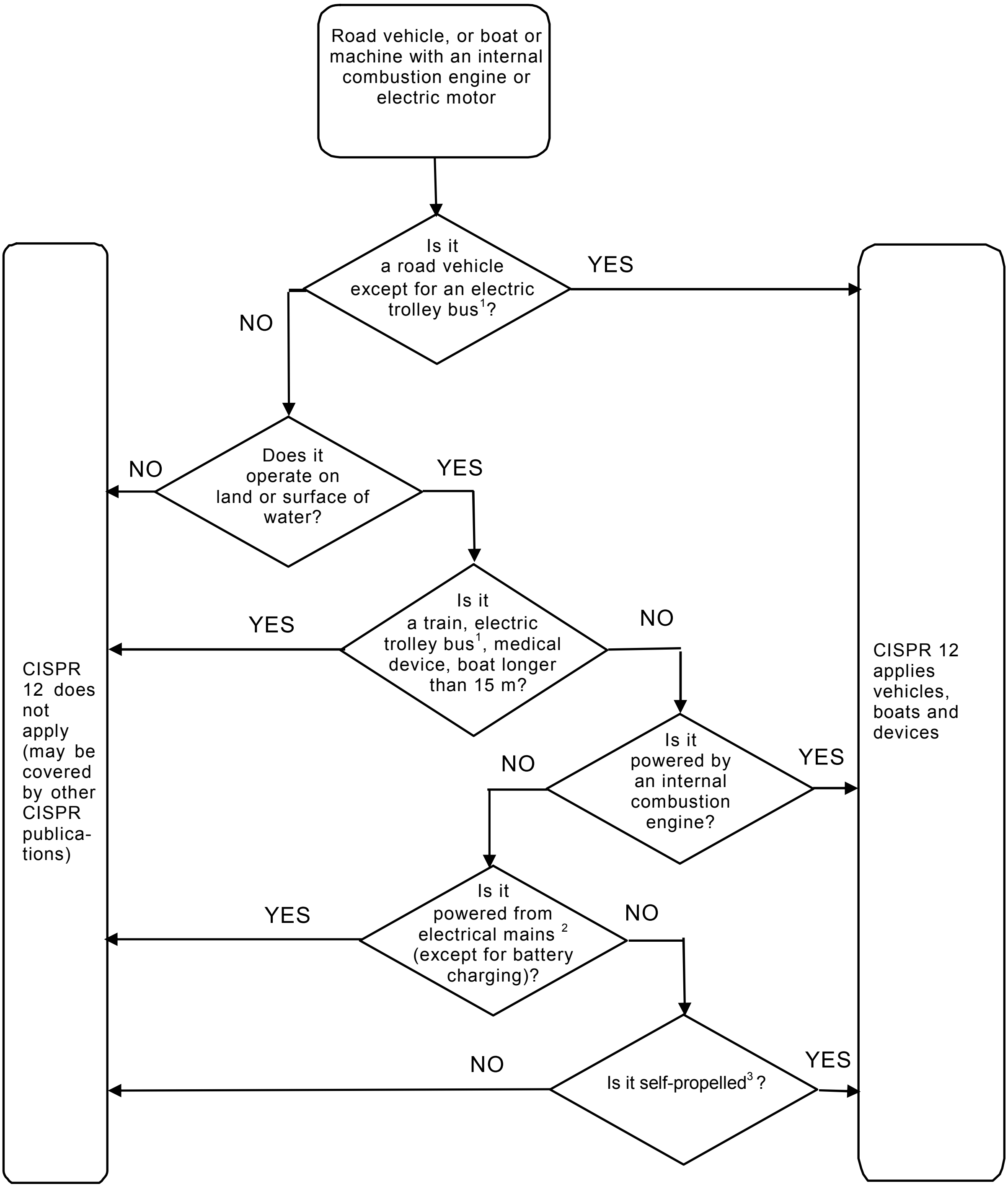
3.16

traction batteries

high power batteries used for electric vehicle traction applications

Annex G

Replace the existing chart and its footnote by the following new figure and footnotes:


Road vehicle, or boat or machine with an internal combustion engine or electric motor
Is it a road vehicle except for an electric trolley bus¹?
YES
NO
Does it operate on land or surface of water?
NO
YES
Is it a train, electric trolley bus¹, medical device, boat longer than 15 m?
YES
NO
CISPR 12 does not apply (may be covered by other CISPR publica-tions)
CISPR 12 applies vehicles, boats and devices
Is it powered by an internal combustion engine?
NO
YES
Is it powered from electrical mains ² (except for battery charging)?
YES
NO
Is it self-propelled³ ?
NO
YES

IEC 2254/08

---

[1] In the case of a dual-mode trolley bus (e.g. propelled by power from either a.c./d.c. mains or an internal combustion engine), the a.c./d.c. mains portion of the vehicle propulsion system shall be excluded from this standard.

[2] Connection to the electrical mains is the work of another CISPR subcommittee.

[3] Automatic battery powered cleaners are the work of another CISPR subcommittee.

(*Continued from second cover*)

International Standard	*Title*
CISPR 16-1-3 : 2004	Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-3: Radio disturbance and immunity measuring apparatus — Ancillary equipment — Disturbance power
CISPR 16-1-4 : 2007	Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-4: Radio disturbance and immunity measuring apparatus — Ancillary equipment — Radiated disturbances
CISPR 16-2-3 : 2006	Specification for radio disturbance and immunity measuring apparatus and methods — Part 2-3: Methods of measurement of disturbances and immunity — Radiated disturbance measurement

Only the English language text of the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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This Indian Standard has been developed from Doc No.: LITD 09 (3024).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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